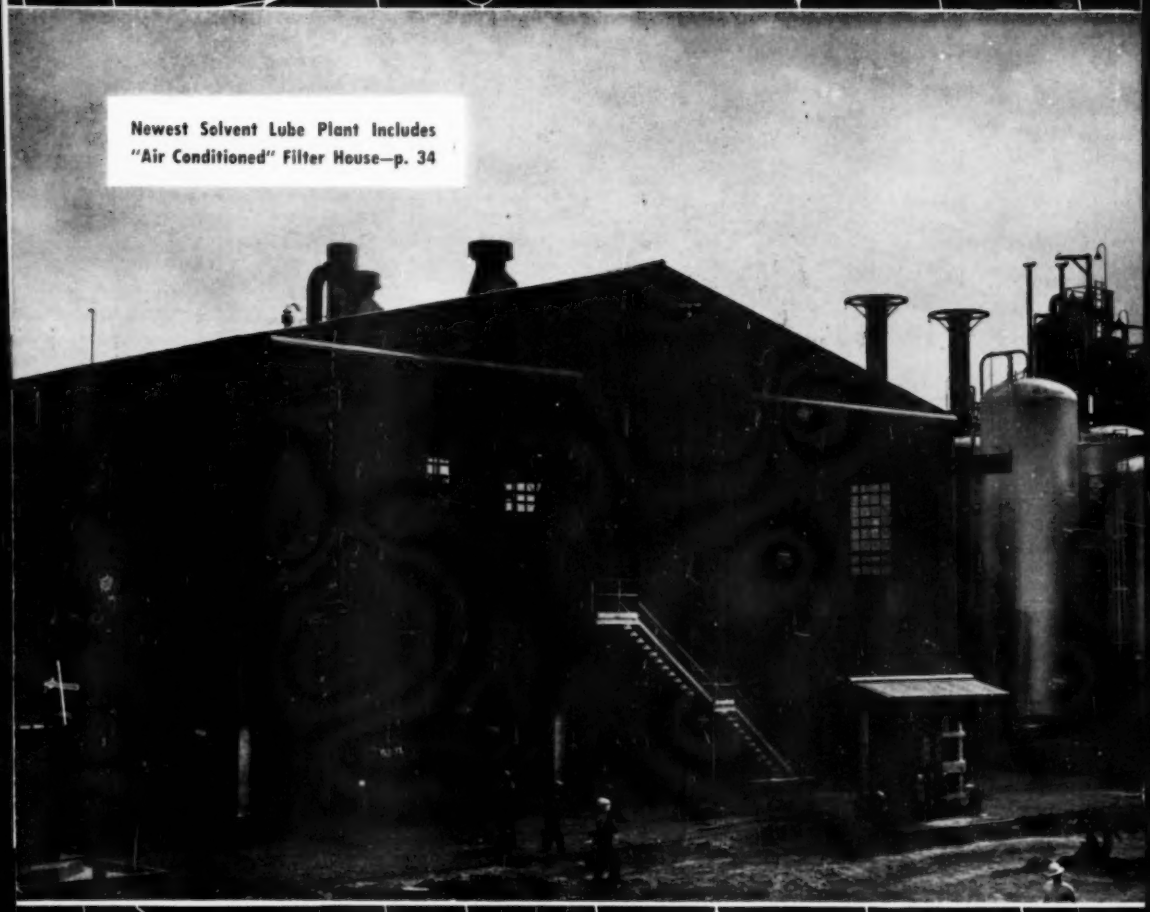
JANUARY, 1951
VOL. 6, NO. 1

PETROLEUM PROCESSING



Newest Solvent Lube Plant Includes "Air Conditioned" Filter House—p. 34

Top Performance

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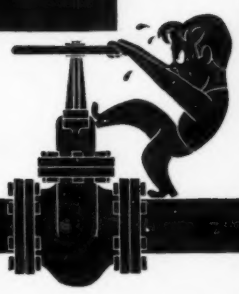

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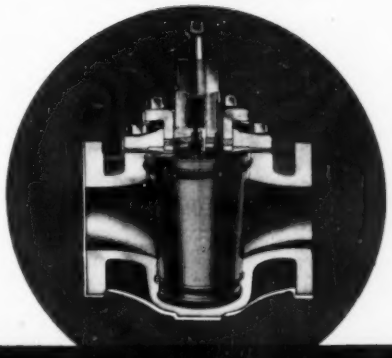
It takes force to close a conventional valve because a wedging action must take place between the gate or disc and the seat in the body. *But no jamming force is needed to close a Nordstrom.* You merely turn the plug 90 degrees. The plug slides on a *lubricated* seat. There's no stress, no distortion, no stuffing-box problem. Lubricant seals the Nordstrom. Lubricant insures easy, effortless operation. The seat is not exposed. Lubricant prevents corrosion and erosion from attacking the seat. Lubricant prevents leaks from starting.



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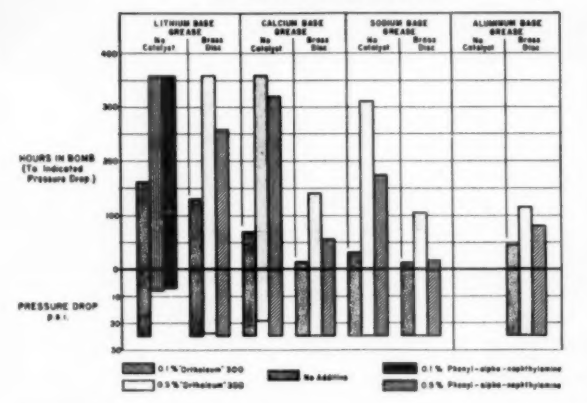
Samples can be obtained for evaluation in your own greases from the nearest Du Pont District Office or from your Du Pont Petroleum Chemicals Representative. For more complete information, ask for Technical Bulletin GS-50.



PHYSICAL PROPERTIES

Appearance	Brown flakes
Melting Range, °F.	
Starts to melt	125
Completely melted	160
Normal Use Concentrations Wt. %	0.2 to 1.0
Miscibility with oils and greases	In all proportions above 160°F. Normal use concentrations soluble at all temperatures.

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Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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. . . for petro-chemical use

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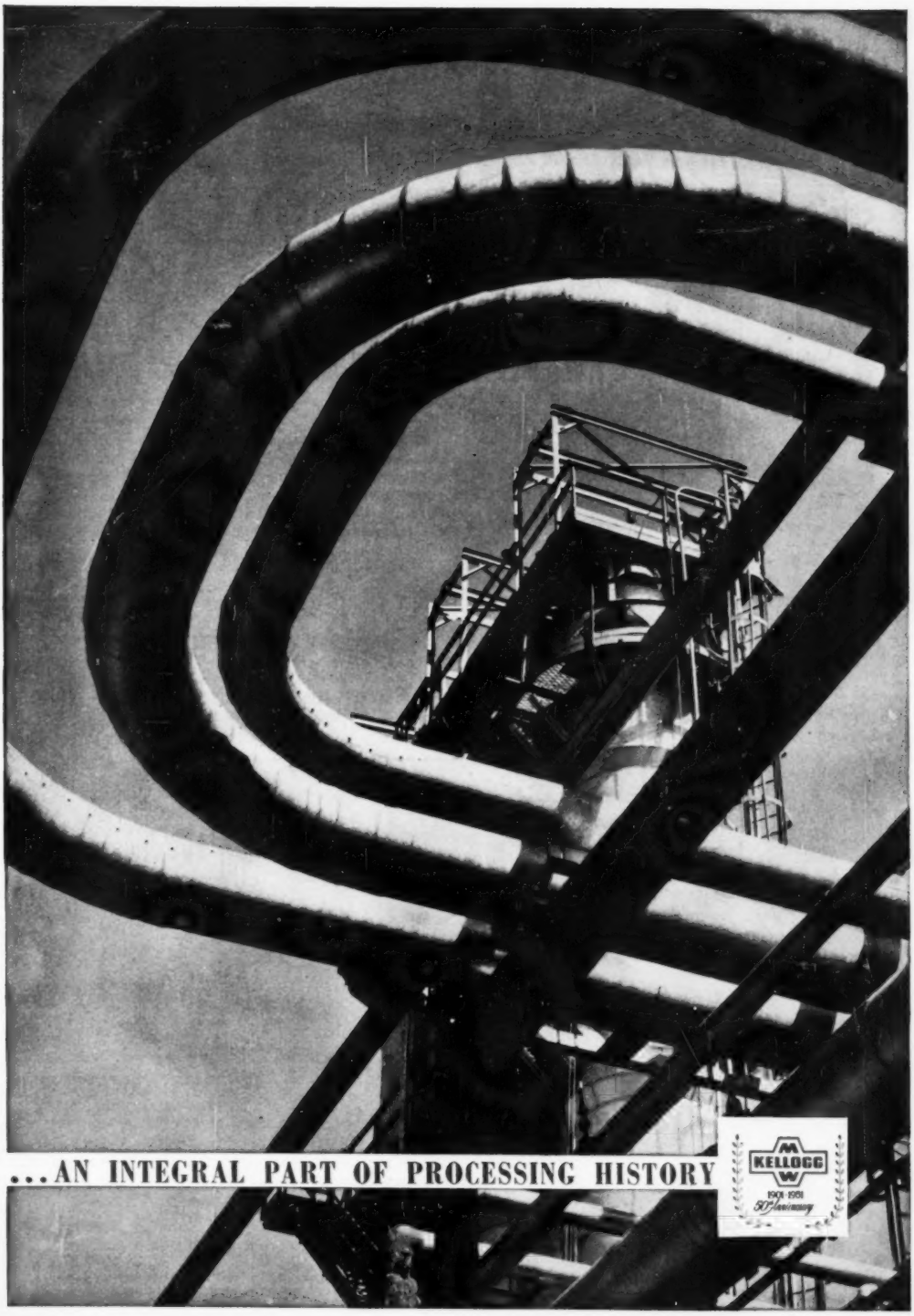
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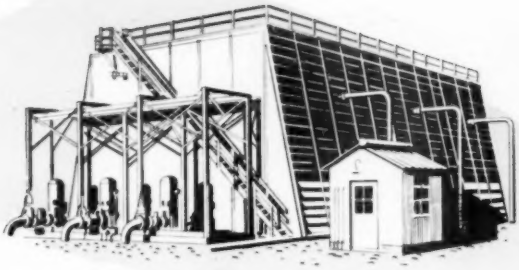

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FOR REFINERY OPERATION — these pumps have what it takes to handle 'round-the-clock, seven-days-a-week, 52-weeks-per-year pumping! Because they are *BJ engineered*, you can be sure they'll measure up to your cooling tower requirements. Because they are *BJ built*, you can be sure of steady-going, low cost operation that won't let you down.

These are some of the features that make BJ Vertical Cooling Tower Pumps dependable performers: *Rigid alignment*—all parts are machined with shoulders and recesses to form metal to metal joints. *Self-priming*—the self-contained pumping unit takes suction from the pit in which it is mounted. *Simple installation*—vertical suspension saves space and cuts installation cost. *Saves piping*—pump element is suspended on a welded steel discharge column with the motor mounted at the top of the column and direct coupled to the driver shaft. Capacities to 7500 gpm and heads as required. Furnished with motor or to fit motor you have.

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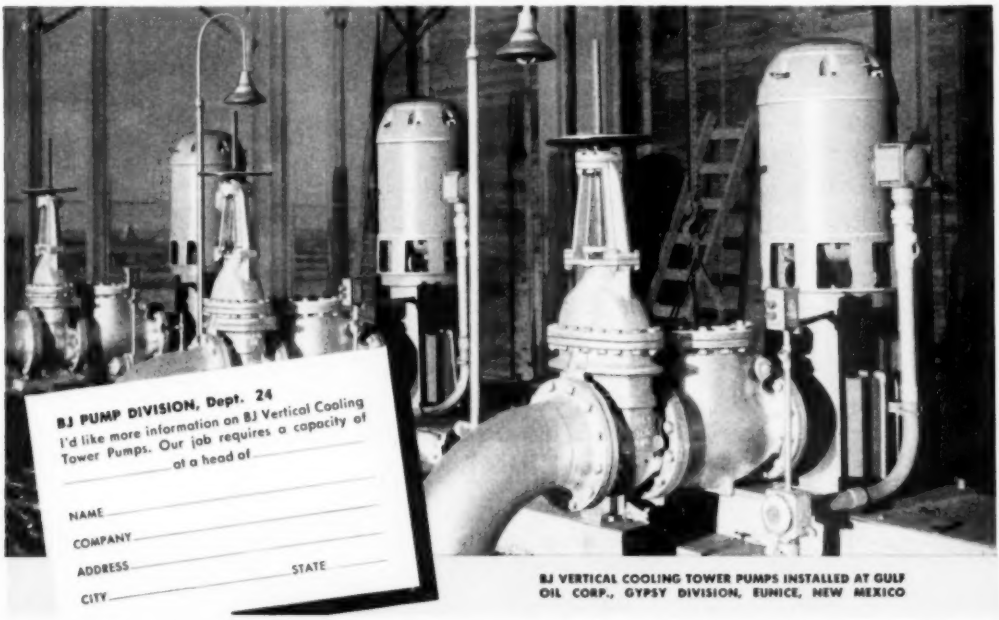

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WHAT'S HAPPENING

Current News Summarized For Oil Men

EXPANSION

Imperial Oil, Ltd., has let contract to Foster Wheeler, Ltd., for construction of a 10,000 b/d Fluid catalytic cracking unit and gas recovery facilities, plus a 10,000 b/d vacuum distillation unit, at its Edmonton, Alberta, refinery. Construction is scheduled to begin this spring, with completion in the summer of 1952. The Fluid unit is described as "first of its kind," although reportedly representing no departure from conventional process. It is said to be "simpler to operate and more efficient" and to have advantages from the construction viewpoint. Standard Oil Development Co. is handling design on it.

Canadian Oil Refineries has awarded first contracts for its new 20,000 b/d Froomfield, Ontario, refinery (Oct. What's Happening, p. 1019) to Canadian Kellogg Co. Kellogg will design and erect several major process sections, including Fluid catalytic cracking, gas recovery and fractionation, and catalytic polymerization units. Construction is scheduled to start in early spring, with the complete refinery scheduled to be in operation in 15 months. Stone & Webster Engineering Co., project managers, has called for bids on other units to be built—including atmospheric and vacuum distillation, and catalytic reforming.

Socony-Vacuum Oil Co. has announced intention of installing a new 15,000 b/d air-lift Thermofor Catalytic Cracking unit at its Paulsboro, N. J., refinery. New unit would be in addition to existing conventional TCC unit at Paulsboro, whereas air-lift TCC units Socony is installing at other refineries are all replacing existing Houdry fixed bed units.

Wilshire Oil Co. is reactivating Fluid catalytic cracking unit (4000 b/d capacity unit built for government) during World War II at its Norwalk, Calif. plant. Petroleum Maintenance Co. has contract.

• • •

SUPPLY and DEMAND

Petroleum tankage capacity in the U. S. increased 26,573,500 bbls. from Mar. 31, 1948, to June 30, 1950, and another 24,344,000 bbls. was expected to be completed during the last six months of 1950, according to report of National Petroleum Council's committee on Petroleum Storage Capacity, released last month. Expected additions boost total storage at refineries, terminals, pipe lines, and in transit to 910,783,000 bbls. Although making no comment on possibility of a need for increasing rate of new storage construction, committee did comment that "The need for additional tankage is practically continuous."

Total crude runs to stills for 1951 are estimated at 6,148,000 b/d according to Bureau of Mines' forecast for new year. This amount represents a gain of about 7% compared with 1950. The Bureau also forecast a total demand for oils in the U. S. during 1951 of 7,162,000 b/d, up 6.2% over 1950.

• • •

FOREIGN

Standard Vacuum Oil Co.'s Sungei Gerong refinery in South Sumatra now is manufacturing liquefied petroleum gas with new processing and bottling facilities which went on-stream Nov. 23. Plant is the first in the Far East and one of the few outside U. S. to make bottled gas. Principal market is presently in the Philippines.

Socony-Vacuum Oil Co. plans to install a new 10,000 b/d Thermofor Catalytic Cracking unit of the air-lift design at its Frontegnam, France, refinery. The company is also considering a smaller unit at its plant at Bremen, Germany.

• • •

MARKETS, PRICES

Hold-the-price line requests from the Economic Stabilization Agency brought a halt to widespread oil price increases scored in early December in almost all refining districts. The advances ranged from 0.1c for heating and Diesel oils in the Southeast up to 3c per gal. for Pennsylvania bright stocks.

Crude prices were boosted in amounts ranging from 15 to 25c per bbl. Penna. grade crude boosted 15c on Dec. 9 by South Penn Oil Co. and other buyers—new price for top-grade Bradford-Allegany oil is $4.25 per bbl. California crude prices hiked 25c per bbl. on Dec. 12 for 14 gravity oils by California Standard, with lesser increases posted for higher gravities. Company posted $1.93 for 18 gravity Signal Hill, up 17c per bbl.

Product price highlights: California Standard boosted fuel oil prices in amounts ranging from 15

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

to 20c per bbl.—new San Pedro bunker price, $1.70 per bbl. Low quoted price for 25 P.T. Penna. bright stock rose from 27 to 30c. Prices for distillate fuel oils were up in amounts ranging from 0.125 to 0.375c for tank car shipments, FOB Group 3. Heavy fuel, same shipping basis, was priced 10c higher at $1.75 to $2.00 per bbl. Natural gasoline prices were up 0.5c per gal., to 6.875c, Group 3, and 6.375c, Breckenridge.

• • •

INDUSTRIAL MOBILIZATION

Interior Department has established four separate new agencies to handle its defense responsibilities other than for petroleum and natural gas. They are Defense Power Administration, Defense Solid Fuels Administration, Defense Minerals Administration and Defense Fisheries Administration.

Basic steel requirements of the refining industry during 1951 are an estimated 717,100 tons, according to figures National Petroleum Council has given PAD. Of this, 298,000 tons would come directly from mills and distributors, and the balance, 419,100 tons, from fabricators and equipment suppliers. Total oil industry steel requirement was set at 12,282,450 tons.

A new Office of Defense Mobilization has been established by President Truman to coordinate the national preparedness program, with Charles E. Wilson, president of General Electric Co., as head of it. The order creating the new office doesn't change present setup as far as PAD is concerned, although it does place in Wilson's hands unlimited authority to realign or abolish existing defense agencies as and if he chooses.

Scarce materials which cannot be hoarded under the Defense Production Act of 1950 are listed in NPA Notice 1, issued Dec. 27. List includes building materials, iron and steel, lumber, and most nonferrous metals (including recoverable scrap).

ORDERS—Following are summarized the more important orders issued last month by NPA and affecting materials of interest to petroleum processors: **Aluminum** (M-7 as amended Dec. 1, and Dir. 3 to M-7 issued Dec. 27), eases restrictions on civilian use of aluminum during 1st quarter of 1951 . . . **Cadmium** (M-19 issued Dec. 27), prohibits use of cadmium, effective Jan. 1, for any purposes or any products not listed in the order . . . **Copper** (M-16 issued Dec. 11, amended Dec. 18), includes provision prohibiting undue accumulation of copper scrap and copper-base alloy scrap . . . **Nickel** (M-14 issued Dec. 1), cuts 1st quarter 1951 consumption of primary nickel for non-defense purposes by 35% . . . **Steel** (M-1 as amended Dec. 1), allows steel producers more time for handling defense orders . . . **Steel** (M-6 as amended Dec. 15), includes Canadian distributor customers of U. S. steel producers . . . **Tin** (M-8 as amended Dec. 18), cuts civilian consumption by 20%, effective Feb. 1 . . . **Zinc** (M-15 issued Dec. 1), limits non-defense production and use to 80% of 1950 level.

APPOINTMENTS—Cecil L. Burrill, as PAD program division chief; he is a director of Creole Petroleum Co.; present job will be to supervise development of an over-all program to assure a supply-demand balance for petroleum and gas and their products . . . **Frank Watts**, as PAD director of materials; he is general sales manager of Humble Oil & Refining Co.; he held a similar post for 14 months with PAW during World War II . . . **Dr. Charles A. Thomas,** executive vice president of Monsanto Chemical Co., as chairman of NSRB's Scientific Manpower Advisory Committee. . . . **Dr. G. G. Oberfell,** retired vice president and director of Phillips Petroleum Co., as consultant to board of RFC, to advise on synthetic rubber program and other matters. . . . **Dene B. Hodges**, vice president of transportation and supplies for Shell, as Director of Transportation for PAD.

• • •

TRANSITION

Quaker State Oil Refining Corp. has shut down the 3,000 b/d Titusville, Pa., plant recently purchased from Cities Service (see What's Happening for August, 1950). Dismantling now is in progress and will be completed by late 1951.

Esso Standard Oil Co. has sold its Buna-N synthetic rubber plant at Baton Rouge, La., to United States Rubber Co. The plant was built in 1941, and now has a capacity of 7,500 tons of Buna-N and high-styrene latex annually. U. S. Rubber plans to expand capacity to 15,000 tons.

Danciger Oil & Refining Co., Ft. Worth, Texas, was merged with Southern Production Co., Shreveport, La., last month—with Southern Production as surviving corporation. Danciger sold its only refinery, a 7,500 plant at Longview, Texas, about two years ago.

• • •

MISCELLANY

Stanolind Oil & Gas Co. has dusted off plans for a new research center in Tulsa, supplementing present facilities now outgrown. To be built on an 80-acre tract company has owned since 1948, new lab will house 350 research personnel. Shreve, Lamb & Harmon Associates, New York, are the architects.

Esso Standard Oil Co. is consolidating its East Coast Manufacturing Division with the New Jersey Works Manager's office at the Bayway refinery, Linden, N. J., effective Jan. 1.

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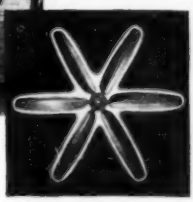

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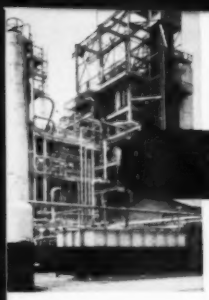

TOMORROW... IN PETROLEUM TECHNOLOGY

Possible Effects of Today's Developments On Future Operations

By the Editors of Petroleum Processing

Suitability and Availability Of Stabilized Steels

IN November the National Production Authority reserved for defense needs the entire output of columbium-bearing stainless steels in this country. That action gives additional point to the discussion now taking place in the steel industry in regard to the substitution of titanium for columbium as a stabilizing agent.[1] Faced for some time with a general shortage of columbium, some steelmakers have been advocating the use of titanium-stabilized steel. While this material is in more plentiful supply, even its use will be regulated in the wartime emergency.

However, even more important for petroleum refiners, the general resulting discussion of types of steel suitable for corrosion and heat resisting purposes has brought statements from authorities who report good performance for the unstabilized and lower grade alloys in refinery applications. M. E. Holmberg, Phillips Petroleum Co., has contributed on this point in a published symposium in *Metal Progress*.[2]

"The oil industry uses large tonnages of 18-8 and other austenitic (unstabilized) steels in gas cracking and in still tubes. Many of these installations are of welded construction. Metal temperatures are generally in the carbide precipitation range during operation. Therefore, it was originally believed necessary to use stabilized grades. Operating experience showed that the inside of the tubes became carburized in service. Because of the increase in carbon content, there was not sufficient columbium or titanium present to keep the metal stabilized. If the tubes do not remain stabilized in service why use stabilized steel in the first place?"

Contributing to the same article, C. L. Clark, metallurgical engineer, Timken Roller Bearing Co. stated: "It is our opinion that the stabilized grades have been used in many applications where they were not needed. Many metallurgists feel that, if the operating temperature is between 800 and 1500° F., either Type 321 (titanium-stabilized) or 347 (columbium-stabilized) must be used. Yet the largest tonnage of austenitic steels used in high-temperature service—until recently at least—has been in the petroleum industry, with metal temperatures of 1100 to 1500° F.

"The standard 18-8 (18% chromium 8% nickel) has been the most widely used austenitic steel, and few if any failures have been encountered while the tubes were hot, even though the conditions were very corrosive and pronounced structural changes occurred, accompanied by intergranular carbide precipitation."

In general, states H. D. Newell, chief metallurgist of Babcock & Wilcox Tube Co.[3] there is a much wider use of the lower chromium-molybdenum alloy steels in furnace tubes and hot oil piping than the stainless grades, the usual steels containing between 2% and 9% chromium with molybdenum.

"Where stainless steel tubing has been used, the stabilized grades have not been necessary, but have been used to a limited extent and for special conditions of exposure following heating within the carbide precipitation range. Much wider use has been made of plain 18-8 Type 304, and several of the major refining companies have used it for many years for heater tubes in thermal cracking units. Other refining companies have been content to use lower alloy steels which are of lesser first cost but require more frequent replacement. Choice depends on specific conditions with respect to temperature, pressure and corrosiveness of the stock being handled and nearly each installation is a separate problem."

With the supply situation tightening not only for the steel stabilizing agents, but also for the alloy elements chromium and nickel, refiners will be called on to revise their ideas of special steels to include types more available, even though their supply is limited. Refiners will find the steel companies' data on the performance and properties of steels much more complete than in 1941-42.

"Orsil," New Engine Coolant, May Lower Octane Needs

HIGHER operating temperatures in automotive engines may not aggravate octane requirements as much as is generally understood to be the case, according to studies recently reported to the Society of Automotive Engineers.[4] In fact, they may in the long run result in lower fuel quality needs than would be required otherwise.

The studies on engine operating temperatures were conducted in connection with a new synthetic liquid, Orsil, which is described as "attractive as an engine coolant." This liquid is one of a family of organic silicate compounds, the outstanding properties of which are high boiling point and very low freezing point.

The particular liquid under consideration has a pour point of —101° F., is pumpable at —70° F., and boils at 680 to 700° F. It retains its liquid phase throughout this temperature range at atmospheric pressure. As a coolant, it will not freeze or boil. It is inert toward metals and materials in the cooling system, and has no limitations with respect to foaming, odor or toxicity. It is stable, does not evaporate, and has an acceptable coefficient of expansion. It is compatible with crankcase lubricants, but is not miscible with water. It is used at 100% strength. It would appear that Orsil was the ideal engine coolant, particularly for sealed cooling systems.

Apparently the only serious drawback the material has is that it does not have heat transfer properties as good as water. It was found that, for equal coolant flow rates, in a given engine, with a given heat transfer system, at equal heat input, and without a thermostat, Orsil will reach an equilibrium temperature 35 to 40° F. higher than water. Further, under these same conditions, metal temperatures in the head on the combustion chamber side and in the bore will reach equilibrium approximately 120° F. higher with Orsil than with water. These higher metal temperatures give rise to new conditions of engine operation.

"Heat basically aggravates octane requirement," the report points out. "From this theoretical consideration only, one would hesitate to accept a condition where metal temperatures around the combustion chamber are increased an additional 100° F. Such considerations, however, should not be accepted dogmatically. . . .

"The octane requirement when the engine is new," it continues, "is not the problem faced by the petroleum industry. Rather, it is the on-the-road requirement after several thousand miles of operation. The increase in octane requirement comes mainly from combustion chamber deposits. The increase can come from hot spots created by scaling in the jackets. Octane requirement increase can come from hotter exhaust valves as poorer seating develops from distorted valve seats. There are undoubtedly many other factors in this very

complicated controversial subject of octane requirement."

As a result of their studies, the investigators believe that some of these causes of higher octane requirement would be eliminated or minimized through the use of some such coolant as Orsil. "These data show," they state, "that a liquid, even though having a heat transfer coefficient less than water—but one that is always a liquid under all conditions of operation—can satisfactorily perform the function of cooling. It will improve the cooling in critical areas by reducing temperature differences."

The results of dynamometer tests in the laboratory showed that:

1—A clean engine with Orsil coolant has an octane requirement about 4 numbers greater than the same engine with water coolant.

2—After 2000 rpm, road load for approximately 3000 miles, an engine with water coolant builds up combustion chamber deposits sufficient to raise octane requirement 22 numbers.

3—Under the same conditions as above, an engine with Orsil coolant has an increase in octane requirement of only 10 numbers. Taking into account the initial increase of 4 numbers, the Orsil-cooled engine then has an octane requirement of 8 numbers *less* than the water-cooled engine.

There are many influences on octane requirement other than the small initial effect of higher operating temperatures, but it would appear that "the petroleum industry, faced with meeting the on-the-road requirements, will not be severely affected by Orsil cooling—and may even be relieved."

Pensioners Are a Sociological As Well as Economic Problem

EMPLOYE relations, industrial relations, or "internal" public relations—use any term and you think about a complex problem of increasing importance every refiner faces. That it's not at all simple is demonstrated by the fact that employes are also the "outside" public. Maybe the average employe doesn't live his job 24 hours a day, and maybe he doesn't take his job home at the end of an 8-hour day. But he does talk about his job and his company—to his friends, neighbors, family. Consequently, industrial relations cannot be separated from overall public relations. It's one of those immeasurable activities every refiner must carry on, even though he can't evaluate results with a profit-and-loss statement.

An interesting example of one refiner's approach to the problem of responsibility to the employe and to the community is in the "Preparation for Retirement" Program initiated recently by Esso Standard Oil Co. in its New Jersey Works.

Esso has accepted the fact that we are becoming a society of older people. In 1900, a person over 48 was living on borrowed time. Today, life expectancy is 65 for males and 70 for females. Today, 10½ million people are 65 or over. By 1960, 14 million will be 65 or over.

These facts are important because in today's group of 65 or over, 70% live on investments, savings, old age pensions, etc. They are consumers rather than producers of national income. Also, our aging population presents a sociological problem. For instance, retired oldsters and many facing retirement soon have tended to form what are potentially powerful political forces. The economic phase of the problem is fairly well solved with pension plans, social security, etc. No such attention has been given the sociological problems. Instead there has been tacit acceptance by industry (and by the worker) that usefulness ends at retirement. Actually, old age is not necessarily senility. Retirement from business is not retirement from society.

What is the solution? Esso feels oldsters must be stimulated and helped to find a retirement that will be active, fruitful, and constructive. Concretely, Esso's approach has been one of counseling rather than paternalism—not a handout but a friendly word of advice. The "Preparation for Retirement" program is in the form of group discussions comprising a series of five meetings lasting about one hour each and at intervals of about four days. It is offered to small groups, 10 to 15, of people whose retirement is about one year off. The program has three principal objectives:

1—Give the prospective annuitant a picture of the problems he is apt to face when he retires,

2—Stimulate organized thinking toward suitable post-retirement interests and activities, and

3—Generate some action on plans before actual retirement.

The group meetings are handled in an atmosphere of informality and free discussion. They are held on company time, but attendance is entirely voluntary. Leaders are for the most part members of the Employe Relations staff. Emphasis is away from the idea that this is a "class" or a training program.

As yet, experience and results are limited because the program is very young. It was tried out first on a carefully selected pilot group, and then on several groups of actual pre-retirement employes. All have given warm and unanimous support to the need for such a program. Attendance, which was voluntary, held up throughout the five sessions.

"Bendable" Cast Iron Shows Promise as Useful New Alloy

ALLOY cast irons as such are not new. One particular alloy, however, has been gaining in prominence and promise since its introduction a little less than two years ago. It is a magnesium-containing (0.06-0.08%) cast iron called nodular, or ductile, iron, and more popularly termed "cast iron that bends."[5]

It can be twisted, bent, and otherwise deformed without fracture, and has several times the strength of ordinary gray iron. Its actual ductility averages about ten times that possible with cast iron. Tensile strengths exceeding 90,000 psi. are normally attained. Fatigue tests conducted on high pressure cylinders demonstrate nodular iron equals and often exceeds the fatigue endurance expected with mild cast steel. Ductile iron has a relatively high resistance to impact and shock. And finally it is comparatively inexpensive.

Compressor builders anticipate new advances in design are possible by substituting nodular iron for the more costly cast steels or steel forgings. Pipe can be cast from the new material as readily as from gray iron. Gray iron pipe failed hydrostatically at 2400 psi. and shattered into a large number of pieces when it burst. Ductile iron pipe expanded under pressure and developed a pronounced bulge in one zone. Failure finally occurred at 5300 psi. in the form of a longitudinal crack along the bulge and with no shattering.

It is believed that ductile iron pipe can be permitted for the transmission of fluids and gases, other than water, now barred to gray iron because of lack of ductility.

Pressure castings in general, regardless of their intricacy, offer possibilities for ductile iron because, if properly fed, there is no doubt of their pressure tightness. Many other interesting applications are being uncovered by International Nickel Co., who holds basic processing patents on the material and presently is licensing its manufacture to about 100 companies operating 300 foundries in this country and abroad.[6]

Production has jumped about fivefold, going from 3500 melt tons in 1949 to an estimated 15,000 to 20,000 tons in 1950.[7]

References

(1) "Conservation of Columbium", by John F. Tyrrell. *Metal Progress*, July, 1950.
(2) "Conservation of Columbium. A Summary of British and American Experience with Stabilized Stainless Steels." *Metal Progress*, November, 1950.
(3) Correspondence.
(4) "A New Engine Coolant," *SAE Journal*, 58, No. 11, p. 33 (Nov., 1950).
(5) "A New Cast Iron That Bends" *INCO*, Vol. 23, No. 4, pp. 4-8.
(6) "Nodular Iron Conference," by William G. Guide. *The Foundry*, November, 1950, pp. 156-158.
(7) "The Nickel Industry in 1950", J. F. Thompson, president, International Nickel Co. of Canada, Ltd., Press release dated December 14, 1950.

Santopoids that can help you meet military specifications

If you are producing, or developing, gear lubricants to meet military specifications, here are four Monsanto Santopoids ready and able to help solve your problems. Condensed specifications of these additives are given below. If you are interested in further information, contact or write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

SANTOPOIDS S and S-RI

Type: Chlorine-sulfur type hypoid gear-lubricant additives.

Properties:

	Santopoid S	Santopoid S-RI
Specific Gravity 25/15.6° C.	1.15-1.20	1.15-1.20
Flash Point °F. C.O.C. (min.)	250	250
Pour Point °F.	below-35	below-35
Viscosity S.U.S. 100° F.	265-340	300-375
Color	Dark Brown	Dark Brown
% Sulfur	10-15	10-12
% Chlorine	30-35	29-33

Applications: Additive for hypoid-gear lubricants. Approved for Federal Specification VV-L-761 lubricants and for former U. S. Army Specification 2-105A gear oils. May be used in a wide variety of gear lubricant bases in transmissions as well as differentials.

Literature: Technical Bulletin O-32.

SANTOPOID 29

Type: Multipurpose gear-lubricant additive.

Properties:

Specific Gravity 60/60° F.	1.09
Flash Point °F.	295
Pour Point °F.	45
Color ASTM (dilute)	7
Viscosity at 100°F.	55
% Sulfur	8.5
% Chlorine	23
% Phosphorus	0.56

Applications: Chlorine-sulfur-phosphorus type extreme-pressure agent for gear lubricants that are designed to meet military specification MIL-L-2105.

Literature: Technical Bulletin O-47.

SANTOPOID 32

Type: Multipurpose gear-lubricant additive for mixed-base black oils.

Properties:

Specific Gravity	1.18
Flash Point °F. (Approx.)	290
Color, ASTM (dilute)	5.5
Viscosity, S.U.S. at 210° F.	50
% Sulfur (Approx.)	8.0
% Chlorine (Approx.)	25.0
% Phosphorus (Approx.)	0.60

Applications: Chlorine-sulfur-phosphorus type extreme pressure agent designed for mixed-base black oils that are designed to meet military specification MIL-L-2105.

SANTOPOID 33

Type: Multipurpose gear-lubricant additive.

Properties:

Specific Gravity	1.14
Flash Point °F. (Approx.)	250
Pour Point °F.	+25
Color, ASTM (dilute)	+0.75
Viscosity, S.U.S. at 210° F. (Approx.)	60
% Sulfur (Approx.)	8.5
% Chlorine (Approx.)	26.0
% Phosphorus (Approx.)	0.56

Applications: Chlorine-sulfur-phosphorus type extreme-pressure agent for gear lubricants that are designed to meet military specification MIL-L-2105.

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SANTOPOUR*
SANTOPOUR B
SANTOPOUR C

Motor oil inhibitors
SANTOLUBE* 395, 395-X, 398, 394-C

Viscosity index improver
SANTODEX*

Gear lubricant additives to meet requirements of Federal specification VV-L-761
SANTOPOID* S, S-RI

Motor oil detergents
SANTOLUBE 203-A, 303-A, 520

Corrosion inhibitor for distillate fuels
SANTOLENE* C

Sludge inhibitor for domestic fuel oils
SANTOLENE E

Cutting-oil additive
SANTOLUBE 52

Inhibitor-detergent combinations for premium and heavy-duty service
SANTOLUBES 205, 206, 360, 374, 379, 521, 522

*Reg. U. S. Pat. Off.

Mid-West Improvements to Include Platforming Unit

By L. A. Woodward, President
Mid-West Refineries, Inc.

The improvement of our product and the expansion of our operation generally to meet market demands, are the reasons behind Mid-West's recent decision to install a Platforming unit and to boost our crude capacity to 10,000 b/d.

L. A. Woodward

The history of Mid-West dates back to the discovery of oil in the Porter field, 14 miles northeast of Alma, Michigan. The company was formed in 1933 and in 1934 a topping unit to handle 1,500 b/d of crude was completed. Initial marketing included straight run gasoline, kerosene, distillate and fuel oil, all of which found a ready and profitable demand. The success of this first unit led to the installation of a second and larger (2,500 b/d) unit which was placed on stream the following year.

Pipelines

Pipelines were constructed from the Porter field, and shortly after, from the newer Crystal field near Alma to the southwest. The discovery of these and other fields led to the construction by other interests of a crude oil pipeline from central Michigan to Toledo, Ohio, since it appeared that the State of Michigan would become an exporter of crude oil. Subsequent years have not justified the earlier beliefs and Michigan has become increasingly dependent upon other areas for an adequate supply of crude oil. As a solution to this all-important problem of crude oil supply, Mid-West Refineries, Inc. has organized a new subsidiary, Michigan-Ohio Pipeline Corporation, which has in turn purchased this crude oil pipeline from a subsidiary of The Standard Oil Company with the intention of moving crude oil into, rather than out of, Michigan.

Michigan-Ohio Pipeline Corporation began operating the pipeline on September 1, 1950 and studies are now under way to determine the best means of coordinating the pipeline with the Alma refinery.

Install Dubbs Unit in 1939

By 1938, competition from other refiners who had begun operation in the same area, proved the necessity for a considerable expansion program and for the conversion of a greater portion of each barrel of crude into products of higher market value. The completion of a Dubbs Thermal Cracker and Reformer in 1939

(Advertisement)

provided for more efficient utilization of the crude we had been processing in our topping plants. At the same time we made other additions including a unit for the polymerization of non-condensed gases from the cracking unit. Thus, we gained important advantages over our competition.

We were able to convert into gasoline, a portion of the 40% heavy residuum from the topping operation, bringing the ultimate recovery of gasoline from each barrel of crude to upwards of 55% as compared with 26% possible with topping alone.

The quality of the gasoline, too, was vastly improved equaling in all respects the performance of any other motor fuel then on the market.

Acquire Second Refinery

Shortly before the war, the company acquired a second refinery located just east of Grand Rapids which had been constructed to take advantage of the crude supply made possible by the discovery of the Walker-Wyoming field. The equipment, including a gathering system and pipeline, was similar to that being operated at the original refinery at Alma.

During the war, the dwindling Michigan supply of crude was augmented by a supply from various Texas sources. With the end of the war, and the relaxing of government supervision of the industry, these sources were no longer open to us and we were faced with the problem of concentrating our crude supply at a single refinery. The Alma plant was selected for this purpose because of its connection with the major pipeline system in Michigan which was mentioned earlier.

At this time the company entered upon a program to broaden its markets, to increase its products and to reduce its dependence upon Michigan crude. A subsidiary company (Mid-West Petroleum Company) was formed for the purpose of owning crude producing properties and purchasing crudes from other sources for exchange purposes and for use at Alma. The refinery near Grand Rapids was sold, but the tankage, loading facilities, pipelines and buildings were retained for use as a terminal which has proved a valuable adjunct to the marketing operation, particularly in home and industrial fuel oils.

The Platforming Unit

Upon completion of our UOP Platforming unit, scheduled for early in 1951, we expect to enjoy an enviable position in our marketing area. Running Michigan and outstate crude oils, we will manufacture a Platformate having a leaded research octane number of approximately 96. Blending this effluent of the Platforming unit with our other products will enable us to deliver to our outlets, a premium grade motor fuel of really superior quality. This should give Mid-West an advantage market-wise for some time to come.

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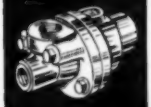
[To obtain more data on advertised products see page 80]



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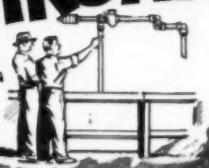

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LETTERS

Crankcase Explosions

The discussion of the paper on "Crankcase Explosions" [December PP, p. 1304] prompts only the following comments:

1) I am sorry that my reference to extremely thin babbitt bearings was misinterpreted by Mr. Boyer, and possibly by others. I intended to bring out the fact that a few thousandths of babbitt can be lost or burned out without the knowledge of the operating crew because a small increase in bearing clearance will not cause noticeable roughness in the engine. As a result, operation is continued until the bearing is sufficiently hot to form and ignite oil vapors. This seldom happened when using the old bearings with thick babbitt because severe pounding occurred before the bearing reached the temperature required to ignite petroleum vapors.

2) Mr. Boyer has presented the obvious answer to Mr. Kates' recommendation when he states that "thorough forced ventilation" would result in excessive oil consumption. This oil loss could be avoided only by cooling the air and oil mixture drawn from the crankcase so the oil could be returned to the engine. This was attempted on the motorship "Reina del Pacifico" with the disastrous results reported in the July, 1948, issue of *British Motorship*.

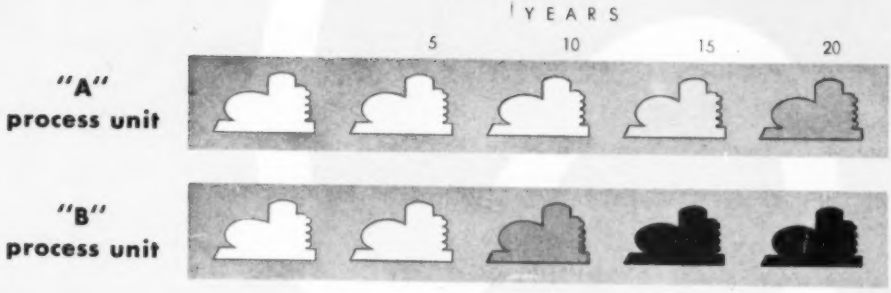
F. V. Cook
Master Mechanic
Service Pipe Line Co.
Tulsa, Okla.

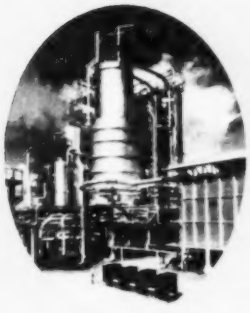
• It is gratifying to note that you have given so much space to this important subject and that you have included abstracts of the discussions of Mr. Cook's paper. I'm glad you called attention to the existing difference of opinion as to the causes of crankcase explosions. There is still much to be learned as to how to prevent them.

As I stated in my discussion, tests have shown that the normal atmosphere of an unventilated Diesel or gas-engine crankcase is explosive. What is now needed are tests to determine how much ventilation is needed to make the crankcase atmosphere non-explosive even in the presence of flame or overheated metal. I believe that such tests would show the practicability of reducing the oil-droplet content (as well as the gas-air ratio in gas-burning engines) below the lean inflammable limit in all parts of the crankcase and that this could be achieved without using excessive amounts of ventilating air.

Edgar J. Kates
Consulting Engineer
New York, N. Y.

what price price?





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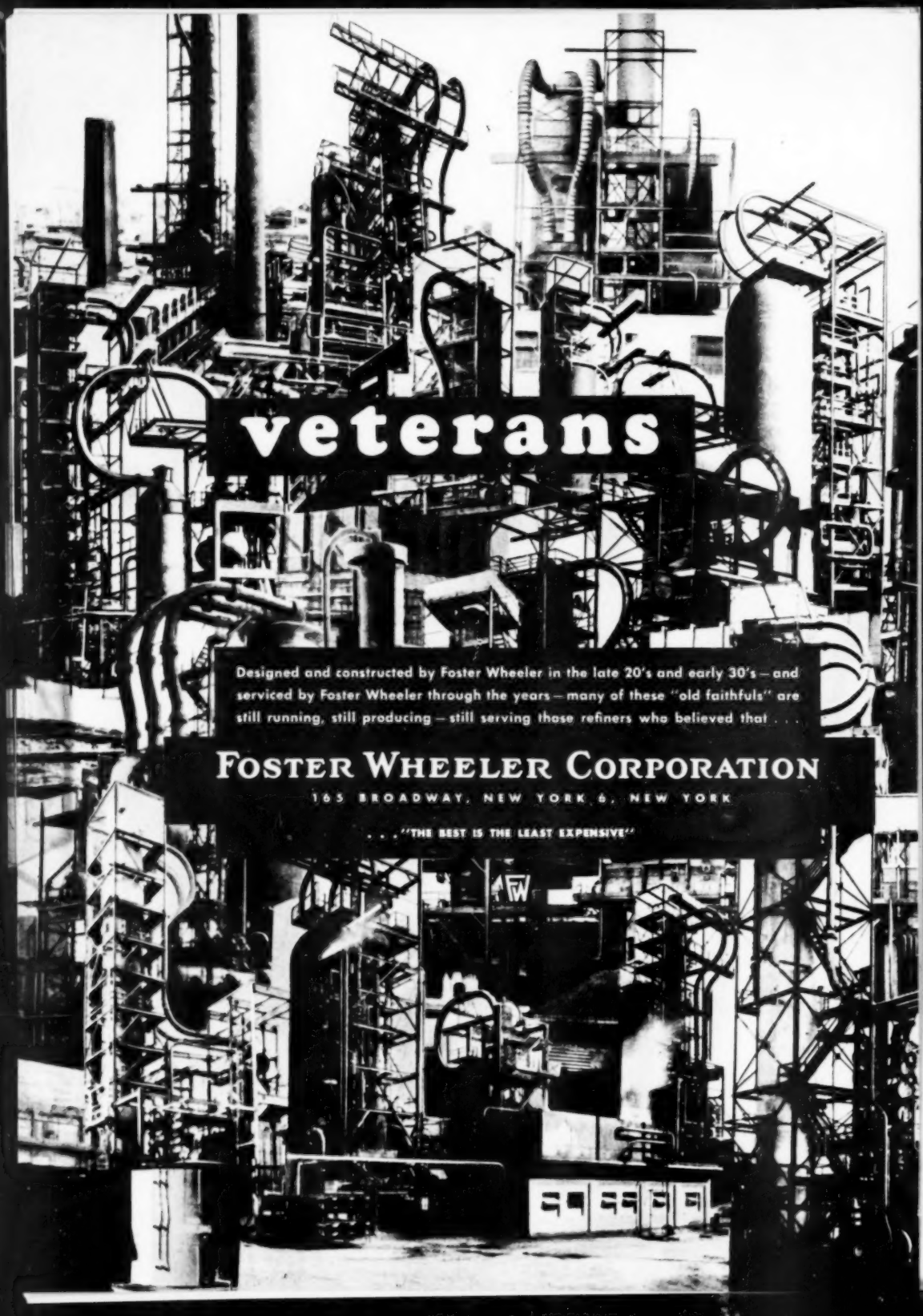
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Designed and constructed by Foster Wheeler in the late 20's and early 30's – and serviced by Foster Wheeler through the years – many of these "old faithfuls" are still running, still producing – still serving those refiners who believed that . . .
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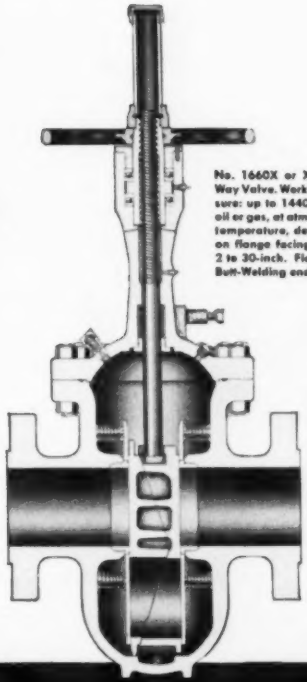


No. 1660X or XH, Full-Way Valve. Working Pressure: up to 1440 pounds oil or gas, at atmospheric temperature, depending on flange facing. Sizes: 2 to 30-inch. Flanged or Butt-Welding ends.

For smoother, unrestricted flow . . . for easier, positive operation . . . these new Crane valves are outstanding performers. Developed especially for oil and gas pipe lines, they incorporate many improvements that add up to more years of maintenance-free, fully dependable service. The following are typical advantages of Crane design.

STREAMLINE FLOW—Disc ports align with seat openings to provide smooth passageway when valve is fully open. No turbulence. Least possible resistance to flow. No pockets to accumulate dirt.

LUBRICATED WORKING PARTS. Body packed with grease to reduce friction and wear of internal parts. Grease provides seal at seats, bonnet joint, and stem, which helps maintain pressure tightness.

DUAL-SEATING DOUBLE DISC wedges tight both in fully open and closed positions. Seals off grease from line fluid; protects disc seating surfaces when valve is open.

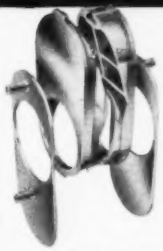
ACCURATE DISC GUIDING assures correct seating and prevents cramping or binding the stem.

PRESSURE-TIGHT BOLTED BODY-BONNET JOINT. Line pressure forces synthetic rubber "O" ring gasket into wedge-shaped groove in body flange and helps keep the joint tight.

GET THIS NEW CIRCULAR

Gives complete information about these new and better pipe line valves—including essential specification data and service recommendations. Ask your Crane Representative for your copy, or write direct for Circular AD-1864. No obligation!

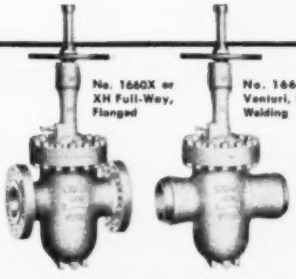
HOW THEY OPERATE



Double disc wedges tightly against shoulder type body seat rings in both open and closed positions. This protects seat faces from erosion and wear.

Movable spring-loaded plates, shown here, retain grease in body and bonnet while valve is being operated . . . also close "conduit" openings in disc against entrance of grease when valve is partly or fully closed.

Only one half of disc is attached to valve stem. At both ends of its travel, the unattached half of the disc comes in contact with stops. Additional wheel rotation then moves the stem-attached half of the disc farther, forcing both discs outward against seat rings and wedging them there.



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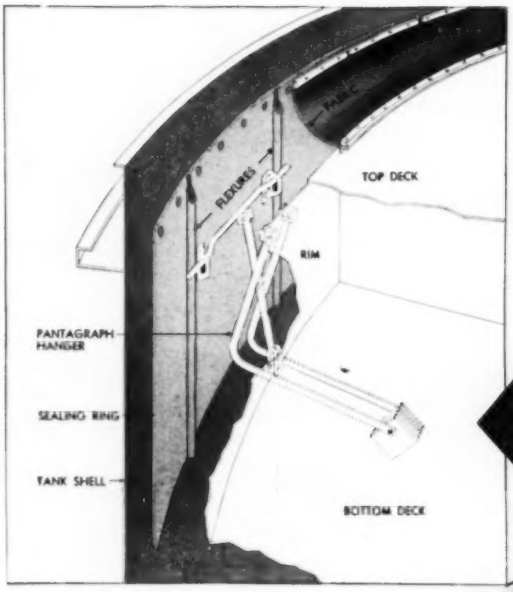


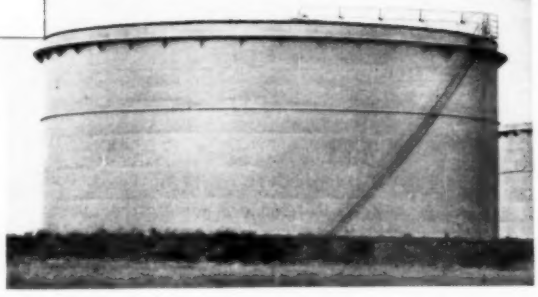
THREE REASONS WHY vapors don't get by the HORTON* Seal

THE improved Horton Seal closes the space between the deck of a Horton Floating Roof and the shell of the tank on which the roof is installed. It is the best device ever developed for this service because of the combined effectiveness of the following parts:

1. ***continuous sealing ring***—The Horton Sealing Ring provides better protection against vapor losses because it forms a close contact with the inside of the tank. Vertical flexures every 22 inches allow the ring to expand and contract enough to conform to the inside of the tank shell. These flexures also serve as stiffeners to distribute the radial pressure exerted by the pantagraph hangers over the entire height of the sealing ring.

2. ***pantagraph hangers***—These hangers support the sealing ring and apply an outward pressure at each flexure. They hold the sealing ring surely but gently against the tank shell so that it maintains a long sliding contact with the inside of the shell as the roof moves up and down in the tank. The pressure exerted by the hangers is just strong enough to insure good contact—but does not cause excessive wear of the sealing ring.

3. ***continuous fabric***—This gastight, weatherproof flexible fabric closes the space between the top of the sealing ring and the deck of the floating roof. Making the space in the seal gastight is an effective, economical way of keeping evaporation losses low from a relatively small area. The fabric is not affected by contact with petroleum liquids and vapors.



Above: 125-ft. diam. by 56-ft. tank that is used to store sour crude oil. It is equipped with a Horton Double-Deck Floating Roof. The liquid level in the tank is so high that the top of the sealing ring (dark ring above shell) can be seen.

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PETROLEUM PROCESSING
JANUARY, 1951

'PAD' ROLLS UP ITS SLEEVES

The role the Petroleum Administration for Defense will take in matters pertaining to oil and gas in the nation's mobilization program was defined by Bruce K. Brown, PAD Deputy Administrator, in an address before the Interstate Oil Compact Commission, in Houston, Dec. 13. The plans for organizing and staffing this wartime agency and for programming its work were also briefly outlined.

PAD will do only those things necessary to cope with emergency conditions, he brought out. Its functions will not conflict with the normal peacetime activities of the established oil and gas agencies in the Interior Department. It has certain direct authorities vested in it, but where final authority lies in another government defense agency, as for example the control of most types of materials, PAD can be a "recommending agency" only.

All its necessary activities, he pledged, will be conducted to preserve to the fullest extent possible during the emergency the free enterprise system which is the foundation of our petroleum and gas industries. Mr. Brown's remarks are published in full here except for a brief introduction.

By BRUCE K. BROWN
Deputy Administrator
Petroleum Administration for Defense

THE Korean situation stimulated enactment of the Defense Production Act of 1950. Under that Act, the President delegated defense responsibilities to the heads of existing government agencies. The Secretary of the Interior was delegated responsibility for power, solid fuels, minerals and metals, fisheries, and petroleum and gas, and he has established special defense agencies to handle each of these fields. The Petroleum Administration for Defense was set up to handle all oil and gas matters relative to defense. Secretary of the Interior Oscar L. Chapman is the Administrator of this agency and I am his Deputy.

I would make clear at the outset that the duties, responsibilities and authorities of the Petroleum Administration for Defense (PAD) are emergent in character. It does not conflict with nor is it subordinate or superior to the normal peace-time functions of the Interior Department. It was created only as the result of the present emergency. It will be staffed only to the extent necessary. It will do only those things necessary to cope with emergency conditions. When the emergency passes it will go out of existence.

Meantime the Secretary, as Administrator, has pledged himself that the necessary activities of PAD will be conducted in such a manner as to avoid, whenever possible and to the fullest extent possible, any impairment of what he likes to call "the free enterprise *competitive* system that prevails in the petroleum industry". I renew that pledge here.

It is our intention to take the fullest cognizance of those principles of organization and operation that were used so successfully by the Petroleum Administration for War during World War II. PAW was recognized by Congress, the states, the military, the public, and by the industry itself as a highly successful operation. It involved a maximum degree of cooperation between all of the parties concerned. The Petroleum Administration for Defense will approach the problems of the present emergency with the history of PAW as its road map, though not its sole guide.

To mobilize our forces as quickly as possible, and in order that we may move ahead with a minimum of initial mistakes, we have called back into PAD some of the experienced men who contributed much to the successful operation of PAW during World War II. However, we will need much more help from the petroleum and gas industry in the line of volunteer expert talent in order that we may become well staffed and stay well-staffed. It would be just as unfair to expect these PAW "alumni" (we call them "re-treads") to carry the full burden as it would be to try to build up our armed forces solely from the ranks of the reservists. We must have new recruits. And should the emergency last as long as some predict it will, it will certainly be necessary to release some of our staff and bring up "fresh troops".

I am stressing this subject of skilled personnel drawn from the oil and gas industry to serve government in PAD. However, I want to emphasize just as strongly that we do not intend to staff PAD solely with men drawn from the industry; whether on a temporary basis or a permanent basis, and whether on the basis of a full-time government salary or "without compensation". Quite the contrary. The oil and gas companies and organizations will have to discharge important defense responsibilities to the public. We do not want to deplete their ranks of skilled personnel. For this reason, and because we have found and can continue to find a great deal of talent for PAD in the form of able individuals who are already career men in government, and from other sources, we will keep down our calls for industry personnel to the minimum feasible under the circumstances.

The Petroleum Administration commences operations with the belief that the industry has the vigor, energy, ingenuity and patriotism to pro-

duce and deliver all of the hydrocarbon fuels and other products required by the military and by the civilian population so long as it can obtain the necessary materials, equipment and manpower to do the job. While the individual consumer obtains his supplies by paying cash, from the standpoint of the national economy the transaction is one of trading steel and other materials for oil and gas. If the supply of materials becomes insufficient to meet the whole need the eventual result is bound to be a partial impairment of the supply of hydrocarbons for fuels and other purposes.

The Petroleum Administration is approaching the problem of mobilizing the petroleum and gas industry for defense with the intention of exerting every effort to keep the supply of materials flowing to the industry in order that we may keep a good supply of products flowing from it. Both jobs will require us to call on the industry for data and advice. As an agency of government it is necessary that we form independent judgements and act solely on those judgements. We must, therefore, "screen" the data and weigh the advice, even though we may value both most highly. The actions that we take —yes, even the mistakes we make— must be our own. Our problem is not solely a domestic one. The problem of petroleum supply is international. The mobilization must be international.

Can Issue Orders

The Petroleum Administration has authorities vested in it and it can issue requests, directives, or orders to industry. However in order to discharge its responsibilities successfully it must depend very largely on the support of other defense agencies. Controls over most types of materials needed by the industry are vested in the National Production Authority, a defense agency of the Department of Commerce. Control over the issuance of certificates for accelerated tax amortization is lodged in the National Security Resources Board. Control over certain types of petroleum transportation is vested in the Defense Transportation Agency, in the Interstate Commerce Commission. Certain other transportation authorities are vested in the Department of Commerce. Thus in many fields important to the industry PAD is only a "recommending agency". Final action will be taken or denied elsewhere. It is essential that our recommendations be made on the basis of sound data and only after careful study and the weighing of alternate procedures.

While the task of assuring a free flow of hydrocarbons to the military and the civilian population may be broadened greatly at a later date,

BRUCE K. BROWN,
Deputy Administrator of PAD

just now it appears to be one with which we can cope by certain activities in the fields of transportation and refining. The transportation problems immediately with us include the question of additional tanker transportation needed by the Military Sea Transportation Service and the immediate evaluation of numerous pipe line projects in the light of supply needs and materials available. Also we must evaluate all transportation available in the light of an overall supply program designed to meet any and every eventuality. The refining problems immediately with us relate to increasing the output of needed military petroleum products, particularly aviation fuels and navy Diesel fuel, from existing facilities, and the planning and approving of additional refining facilities for these and other products.

Materials a Real Problem

While, as I have suggested, the task of assuring a flow of products *from* the industry can be handled, under present conditions of mobilization, by certain specialized actions, the task of assuring a free flow of materials *to* the industry is with us right now on a very broad basis. We hear complaints of slow deliveries or no deliveries from every branch of the oil and gas industry. The shortages or feared shortages are by no means confined to oil country tubular goods, though that particular shortage has had more attention in the press than any other. Tank car construction programs, privately financed and ready to go, are slow in execution.

Even the rehabilitation of World War II 100-octane gasoline units is rendered difficult by the relative unavailability of certain alloys. New pipe line projects for both oil and gas are serving notice of need for very large quantities of pipe. An expanded barge construction program is in the offing. The needs for material of American oil companies operating abroad, while not a large proportion of the total requirement, must have special attention because of the additional complications of the supply operation which necessarily involves still other agencies of government and foreign governments, as well as specialized problems in the fields of inventory and the practical delivery of the needed items.

Commencing in 1947 and continuing up until the present time the industry's Military Petroleum Advisory Board working under the direction of the Munitions Board Petroleum Committee and the Oil and Gas Division of the Department of the Interior has been evolving an over-all "program" for fueling the military and the civilian populations of the U. S., its allies, and friendly countries in the event of an international emergency.

Must Estimate Needs

In constructing and maintaining such a program it is necessary to estimate the needs under certain assumed circumstances and then to try to ascertain whether they can be met or what steps need to be taken to meet them. This involves studies of crude oil and gas availabilities and reserves, refining capacities, transportation capacities, storage availabilities, and the like. Implicit in such work is the assumption that steel and other materials will be forthcoming to sustain *and* expand the industry along the lines indicated by the program and that the manpower will be available.

In every one of these fields, the availability of materials and manpower is the key to the situation. And in dividing the available material and manpower it would be foolish indeed to assume that any one feature of the program had an overwhelming "first priority". A supply of crude is valueless unless it can be transported to refineries. Refineries are valueless unless there is crude. Both are valueless unless the products can be transported and stored. Expansion of refining capacity is valueless if achieved in such a way as to divert steel from needed gas transmission and distribution operations so that the only end result is to soak up the additional refined products in satisfying a new heating load that could be served with gas.

When PAD was established we tried to "put first things first" and — as will be evident from the preceding discussion—our first needs were for a Program Division and a Materials Division. The Program Division will take over and expand the work already done in the field of cataloging and

weighing our over-all problem. The Materials Division will carefully examine the material requirements of the petroleum and gas industry and express these requirements accurately and forcefully to the agency in charge of materials; that is to the National Production Authority. As I have stated, the materials problem has two parts—material to sustain the industry and material to expand it. Materials simply must be forthcoming to sustain the industry. Requirements of materials to expand it must be evaluated in the light of our over-all program and the availabilities of additional materials and manpower.

Will Analyze Each Project

Individual projects involving expansion, whether in the fields of transportation, refining or distribution will require technical analysis as well, that is, analysis by experts in the operating fields in question. Only upon their recommendation, and after they have weighed various alternates and expressed opinions as to the value of the projects, can such projects be included in our over-all program.

Thus far I have tried to express the fundamental philosophy back of the organization of the Petroleum Administration. Its size and the scope of its operations will depend on the state of the emergency, both the national emergency and such business emergencies as the industry may find itself in as the result of the impacts of mobilization. However I do not think the principles I have expressed should or will change in the future.

Turning now to our immediate situation: We are in throes of organization and have not yet progressed very far. We lack personnel and if all of the personnel needed should suddenly appear, we would have no place, literally, for them to sit down and do their work. We hope to cure both difficulties. Hugh Stewart, who has served ably as the Director of the Interior Department's Oil and Gas Division is still the titular head of that organization (which is still legally in existence), but his active work is to serve as an Assistant Deputy in the Petroleum Administration for Defense. He will serve generally as our top man in all production matters and will be our representative to the state regulatory bodies and the Interstate Oil Compact Commission. Further, he will be a general assistant to me.

Other members of the peacetime Oil and Gas Division have transferred their activities to PAD and we have already recruited some highly able, patriotic members of industry for full-time service and for advisory service. The National Petroleum Council will advise us and, as we can, we will set up special industry advisory committees to help us in various fields. We hope to maintain close and cordial relations with the Compact, the State regulatory bodies, and agencies of the Federal Government.

Setting Up Divisions

Highly competent men are already heading our Program and Materials divisions of PAD, although we have still to staff them with supporting personnel. Highly competent men have for weeks been at work in the Aviation Fuels section of a yet-unestablished Refining Division. We hope very soon to announce the establishment of a Supply and Transportation Division. We must establish at least the nucleus of a Foreign Division. We are staffing an "Office of Financial Counselor", to set up uniform standards for our recommendations relative to loans, purchases, tax certificates, certification of extraordinary expenses, etc., and to advise our operating divisions concerning the most expeditious ways in which the financial aspects of their programs can be handled. As yet we do not have a General Counsel. We could not have moved ahead in any of the fields I have mentioned without the devoted assistance of several former PAW counsel and I hope soon to be able to announce appointment of a highly able individual on a full-time basis as PAD's General Counsel.

Down the road we shall undoubtedly meet vexing problems relative to production of oil and gas, transmission and distribution of gas, supply and distribution of liquid petroleum, manpower, and security. We will do our best to meet these problems squarely when they come up.

Summary of Situation

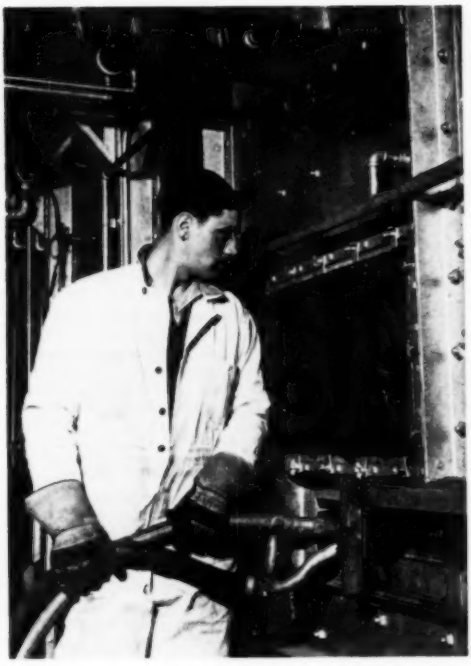
Summarizing our situation — we have much yet to do before we will be well organized to cope with present conditions and threatened conditions, but I am sure we can manage it. In the interlude between V. J. day and the Communist invasion of Korea the petroleum industry did not forget its responsibilities for national security. We learned our lesson. We never forgot that over 60% of the dead weight shipped overseas to support World War II, counting men, food, equipment and munitions, was petroleum. We remembered that a mobilization economy had required more, not less, petroleum and gas for the civilian population at home. We shuddered at the development of fuel-eating jet planes because we knew that their use would make our military supply problem still more difficult; but at the same time we buckled down to the job of anticipating such increased requirements.

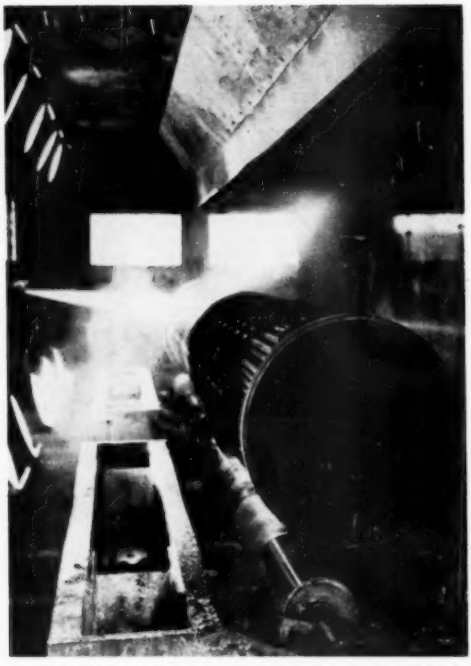
Between the victory over Japan and the Korean invasion, the Oil and Gas Division was sustained in the Interior Department, with the support of the industry. The National Petroleum Council kept at work, replacing the Petroleum Industry War Council. The Munitions Board Petroleum Committee is the titular successor of the wartime Army and Navy Petroleum Board and its staff, both military and civilian, has kept alive the military appreciation of petroleum problems that was learned the hard way early in World War II. The industry's Military Petroleum Advisory Board has worked to fill a part of the gap created by the dissolution of PAW, so that the military would continue to have competent advice on its own petroleum problems. With all of this background to draw upon, the Petroleum Administration for Defense confidently expects to be able to help the oil and gas industry to do a good job in this emergency period.

PAD Personnel

Following is a listing of the key personnel so far appointed to the staff of the Petroleum Administration for Defense (with their former company connections given in parentheses):

Administrator—Oscar L. Chapman (Secretary of the Interior)
Deputy Administrator—Bruce K. Brown (President, Pan-Am Southern Corp.)
Asst. Deputy Administrator—Hugh A. Stewart (Director, Oil and Gas Division of Interior).
Avgas Program, Director—A. P. Frame (President, Cities Service Research and Development Co.).
Avgas Program, Asst. Director—T. L. Apjohn (Research and Development Dept., Socony-Vacuum Oil Co.).
Materials Division, Director—Frank Watts (Sales Manager, Humble Oil and Refining Co.).
Materials Division, Asst.—P. W. Cox (Washington engineering consultant).
Program Division, Director—C. L. Burrill (Director, Creole Petroleum Corp.).
Program Division, Asst. Director—R. N. Sears (Phillips Petroleum Co.).
Supply and Transportation Division, Director—D. B. Hodges (Vice President, Shell Oil Co.).





All photos by William Frutchey, courtesy Esso Standard Oil Co.

OPERATOR OUTSIDE—OPERATIONS INSIDE: Water hose (braided) and sand hose join at nozzle, which rides in rolling cradle, passes through rubber slot. Jet is guided by watching through window. Bundles are on rollers inside illuminated room

High Pressure Water + Blasting Sand = CLEANER HEAT EXCHANGERS

A high pressure, wet sand blasting unit at Esso Standard Oil's Bayway refinery has largely supplanted all other methods of cleaning heat exchangers. With an anticipated average improvement in heat transfer coefficient in tubes of 5%, the equipment is expected to pay for itself in about one year, based on the current annual cleaning load of 300 exchanger bundles. High penetration of the bundle to knock out scale and deposits from inner tubes is obtained by a jet of sand flowing at about 100 lbs./min. with water at 30 gpm. under 1200 psi. pressure. Sand loss is low—10% or less—most of the abrasive being reclaimed by a recycling system.

By WILLIAM C. UHL
Equipment Editor

A HIGH pressure water stream hurling abrasive blasting sand in a high velocity jet at heat exchanger bundles has been shown to be an effective method for cleaning such equipment in a full-scale commercial installation at the Bayway refinery in Linden, N. J. of Esso Standard Oil Co.

The cleaning unit is expected to show a 5% average improvement in heat transfer coefficient in exchanger tubes compared to former processes such as dry sand blasting, drilling, or acid pickling. Individual cases may put the improvement as high as 15 to 20%, Esso engineers believe, but the 5% average represents a reasonably attainable goal that will be economically advantageous to the company.

Handling an estimated current cleaning load of 300 bundles per year, the maintenance shop should be able to pay off the new cleaning process in about one year based on the 5% improvement. Initial investment on the new unit was in the neighborhood of $42,000, installed. The improved heat transfer coefficient will effect immediate heat savings, and will increase throughput because higher capacities can be realized from the greater rate of heat transfer.

Illustrated in the pictorial flow diagram, Fig. 1; and in the various accompanying photographs, the Bayway tube bundle cleaning installation is a relatively simple piece of equipment. It consists chiefly of the sealed cleaning room proper, large enough to accommodate virtually all sizes of bundles, a source of fresh sand and water with one or more appropriate "guns" or nozzles, and a circulating and separating system to

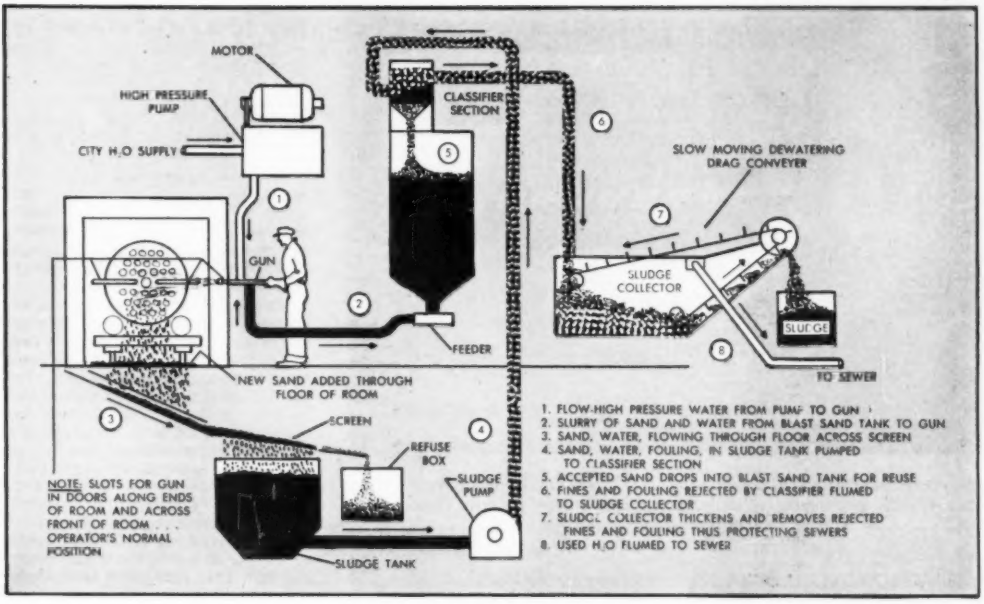

MOTOR
HIGH PRESSURE PUMP
CITY H₂O SUPPLY
CLASSIFIER SECTION
SLOW MOVING DEWATERING DRAG CONVEYER
GUN
SLUDGE COLLECTOR
SLUDGE
FEEDER
TO SEWER
NEW SAND ADDED THROUGH FLOOR OF ROOM
SCREEN
REFUSE BOX
SLUDGE PUMP
NOTE: SLOTS FOR GUN IN DOORS ALONG ENDS OF ROOM AND ACROSS FRONT OF ROOM . . . OPERATOR'S NORMAL POSITION
SLUDGE TANK
1. FLOW-HIGH PRESSURE WATER FROM PUMP TO GUN
2. SLURRY OF SAND AND WATER FROM BLAST SAND TANK TO GUN
3. SAND, WATER, FLOWING THROUGH FLOOR ACROSS SCREEN
4. SAND, WATER, FOULING, IN SLUDGE TANK PUMPED TO CLASSIFIER SECTION
5. ACCEPTED SAND DROPS INTO BLAST SAND TANK FOR REUSE
6. FINES AND FOULING REJECTED BY CLASSIFIER FLUMED TO SLUDGE COLLECTOR
7. SLUDGE COLLECTOR THICKENS AND REMOVES REJECTED FINES AND FOULING THUS PROTECTING SEWERS
8. USED H₂O FLUMED TO SEWER

FIG. 1—Pictorial flow diagram of the heat exchanger cleaning unit

remove sludge and water and to recover usable sand. Known by the trade name "Hydro-Sand Blast Unit," the equipment was designed and built for Esso by the Pangborn Corp.

Located in one corner of the Bayway refinery boiler shop, the unit occupies a floor area measuring approximately 30 x 31 ft. In addition, a space 24 ft. long x 6 ft. wide extending from one side is provided to permit moving exchanger bundles in and out of the unit on rails. Overall height, including a large exhaust fan on top of the cleaning room, is a little over 15 ft. Excavations below the floor level for pits approximate 12 to 15 ft.

Use City Water

In operation, city water is sent through a 30 gpm. Worthington pump, driven by a 25 h.p. electric motor. It then flows at 1200 psi. to the aspirating gun. At that point it picks up the clean blasting sand and flows in a mixed jet through the nozzle. Sand flow rate has been set at about 100 lbs./min. for most satisfactory cleaning. Nozzles are operated manually, the operator directing the jet at the exchanger bundle inside the cleaning room. The gun passes between close-fitting rubber lips on a slot which runs almost the entire length of one side wall, the rear and the front doors and 3½ ft. above the floor. This is about waist height, a comfortable and normal position for the blastgun operator.

The jet can be directed at the sides of the bundles and also into the tube ends. It is planned to improve the angle of attack for the tube end work by lowering the nozzle inside the room on a pantograph device. Only one gun is being used at present. Two can be used by installing another pump and increasing slightly the size of the sand storage hopper, thereby doubling the production.

Sand, water, accumulated dirt, scale, and the like from the cleaning operation flow through a steel floor plate with ⅜-in. perforations to a concrete sump below floor level. The bottom of this sump slopes gently to the center of one side wall in a shape essentially that of half a flat cone. The mixture then flows over a vibrating screen, actuated by a 2 hp., 1800 rpm. motor. Water, sand, and fine materials pass through the screen into a sludge tank. Coarse refuse flows over the end of the screen where refuse is collected in a box. The refuse receptacle and final sump must be cleaned periodically. The screen mechanism, sludge tank, and refuse box are located in a 12-ft. deep pit alongside the cleaning room. A ¼ hp. 20 gpm. sump pump takes care of leakage from the outside or from the pump glands.

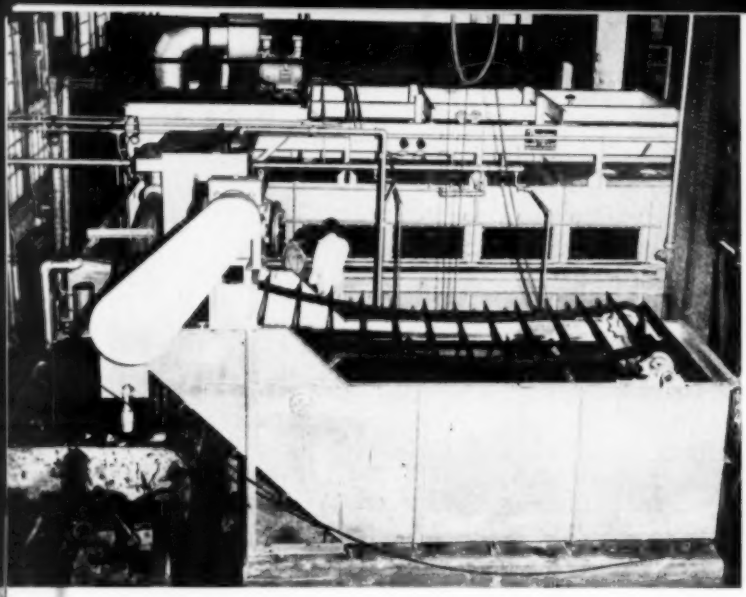
Sludge mixture is picked up by 200 gpm., rubber-lined, Allen-Sherman-Hoff centrifugal pump, driven by a 7½ hp., 1200 rpm. motor. It flows up to a weir type classifier on top of the sand storage hopper. Accepted sand drops into the tank for re-use. Sand loss is kept extremely low because of the closed recycling system. Make-up averages 10% or less. By comparison, Esso's dry method of air-sand blasting uses nothing but new sand, none being reclaimed.

Fines and fouling rejected by the classifier are flumed to the large sludge collector, which thickens and removes rejected sludge to protect the plant sewers. Water only is flumed to the sewer from this unit. The slow-moving drag conveyor in the sludge collector is powered by a 1 hp., 1200 rpm. motor.

Cleaning Room Dimensions

Dimensions of the cleaning room are 26 ft. long x 10 ft. wide with 7½ ft. of headroom. The door opening at one end, through which bundles or other equipment to be cleaned are passed, measures 7½ ft. wide x 6½ ft. high. Equipment is moved in on a flat car rolling on standard gauge rails in the floor. Once in the room, it can be handled by an overhead monorail crane of 3-ton capacity, which operates through a slot in the ceiling. Also, bundles lay on a cradle with rollers to permit rotation during cleaning operations.

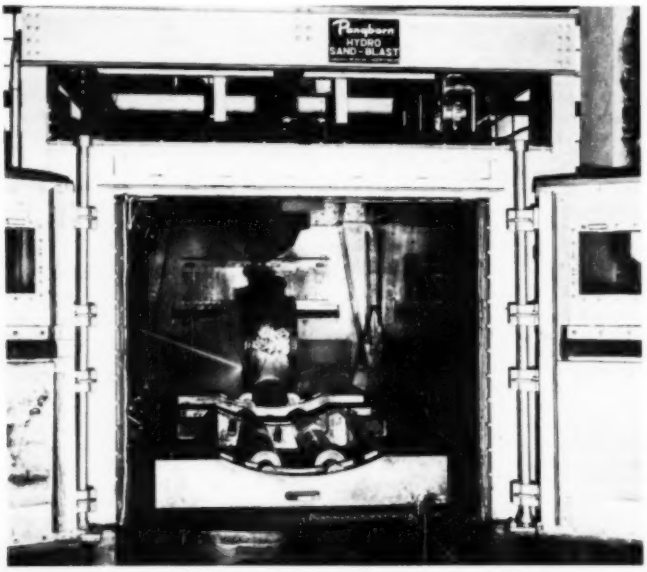
Windows in three walls of the room provide ample vision for the operators. The interior is illumi-



COMPLETE INSTALLATION at Bayway shops includes cleaning room proper (background), with exhaust blower on top, and sludge collector (foreground), with sludge cart at left

nated by two banks of lights along one side wall. One bank is about a foot below the ceiling and another about the same distance above the floor. Permanently installed nozzles permit sending fresh, clean wash water over the lights and the windows to maintain proper vision. There are also fixed washer jets in the pits to remove accumulations of sludge, sand, and the like. The wash system is controlled manually by valves and utilizes regular plant water at about a 70 gpm. flow rate, intermittent demand.

An overhead air circulation system completes the auxiliary equipment installed at the cleaning room. This comprises four air inlets in the ceiling near one end and an exhaust outlet at the opposite end. A rotary blower driven through reduction pulleys by a 7½ hp., 1800 rpm. motor exhaust to a separate dust collecting system via 16-in. ducts. The capacity of the exhaust blower is 7500 CFM.



OTHER TYPES OF EQUIPMENT can also be cleaned in the sand-blast unit, as shown in this view through opened doors

The cleaning unit went into service about the middle of March, 1950. After it had been in use a month, Esso's engineers made a preliminary report which indicated the degree of effectiveness of the installation. This report stated:

"Efficient exchanger operation depends to a great degree on the effectiveness of the cleaning. Rarely does a cleaned exchanger ever approach the original new efficiency. Improved cleaning can only aim at narrowing this gap. To illustrate the improvement expected from the Hydro-Sand Blast cleaning, two typical cases have been chosen: 1) a tar bottoms to fresh feed exchanger on a naphtha reforming or thermal cracking operation, and 2) a fresh feed to middle cut circulating reflux exchanger on a Fluid catalytic cracking unit. The changes in heat transfer coefficient versus time are indicated in the two graphs in Fig. 2. In each graph, the solid line curve represents actual operating during a typical run in 1949, starting with a clean bundle and running until it is removed for re-cleaning.

Heat Transfer Formula

"The heat transfer coefficient, H_o is measured in Btu./hr./°F./sq. ft., but it may be further defined by the formula:

$$H_o = \frac{Q}{A\Delta T}$$

where:

Q = Total heat to be transferred in Btu./hr., a function of both media, their flow rates, and their temperatures.

A = Effective surface of the exchanger.

ΔT = Mean temperature difference between media.

"It is apparent that Q and ΔT are functions of operation, while A is not just design but is dependent on fouling. Fouling reduces the 'effective area.'

"Studying the solid lines of each graph in Fig. 2, it is apparent that fouling progressed rapidly at first and then levelled off after six to eight weeks of operation. The humps and bumps indicated are caused more by changes in operation affecting Q or ΔT than actual reduction of fouling. It may be noticed that after each such change the coefficient returns to the normal curve, indicating a steady increase in fouling.

"Over the years, cleaning methods have progressed from simple blowing

with air or water, to turbining and drilling, to acid pickling, to sand blasting. Each method has had limitations and frequently combinations of all the methods have been employed to dislodge particular deposits. With each improvement, increases in the 'clean' bundle heat transfer coefficient have been realized.

Air-Sand Is Limited

"The use of sandblasting in the last few years has proved extremely advantageous, but still had a limitation in its effectiveness in penetrating the bundle more than two or three rows of tubes. As it was recognized that the air-sand blast stream lost most of its effectiveness after the first impact, the advent of hydro-sand blasting appeared to be the solution. Due to the weight of the water stream, the entrained sand is an effective cleaning agent even after several impacts.

"Returning to the graphs in Fig. 2; the lower dotted lines show a contemplated 5% increase in cleaning effectiveness with fouling in parallel with former rates. The area between the solid line curve and the expected conditions represents dollars in terms of Btu. or fuel or crude. Actually, it is expected that 'clean' coefficients will be increased possibly 5% in the majority of cases, this conservative figure having been chosen to measure the effect of a refinery-wide improvement.

"The upper dashed lines in Fig. 2 represent a further hoped-for increase in efficiency, not alone due to the 'clean' coefficient. For years, it has been felt that a cleaner bundle will tend to stay cleaner longer due to the absence of nuclei or surface irergularities to catch the new deposits. Hydro-Sand blast has already indicated a marked polishing effect which should be reflected in such an increase in efficiency.

"It must be understood that both the dotted and the dashed lines are ony conjectures to indicate the justification for going to Hydro-Sand Elasting. Actual performance characteristics will have to await several months of service on various operations before reliable evaluations can be made."

Expect Firm Results in Spring

Esso anticipates complete, firm results on their work with this new unit by the spring of 1951. Meanwhile, the wet sand blasting technique has replaced entirely other methods or combinations of methods formerly used at Bayway for cleaning exchanger bundles. Methods eliminated include acid pickling, air-sand blasting, and some mechanical cleaning. The process department early requested that acid pickling be stopped, and since the new unit was installed the number of bundles to be cleaned has been stepped up.

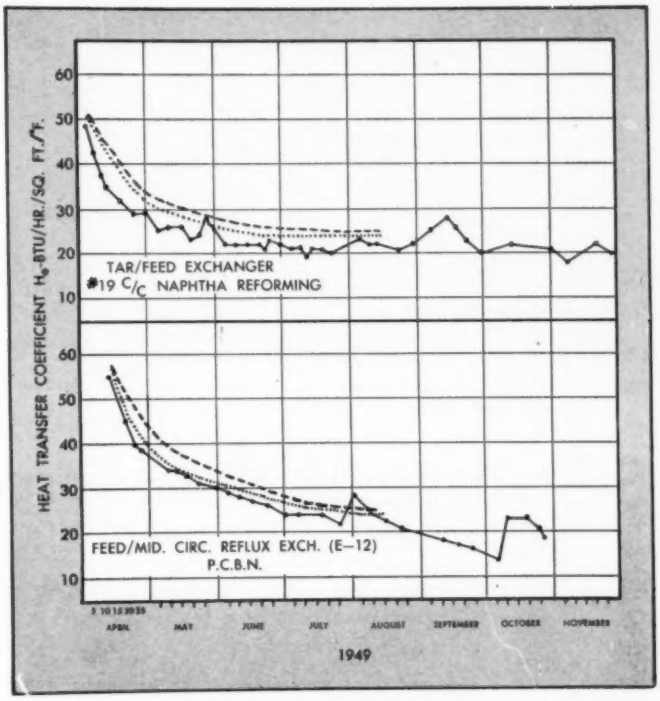


FIG. 2—Effects on heat transfer coefficient by different cleaning methods

In addition to the direct advantage of improved fuel economy through better heat transfer, this new installation has made possible an indirect saving in overall maintenance costs. Previously, the various cleaning methods were carried on at widely scattered locations on the refinery property. Now, all cleaning is done in one central location at the Hydro-Sand Blast unit in the boiler shop building.

There is no indication of any time saving over other techniques. A cleaning job takes about as long with the water and sand as it has with dry air-sand blasting. The principal objective of the installation is to provide the cleanest bundles possible rather than being concerned with time saving. It is felt that cleaner bundles will give longer service and fuel economies.

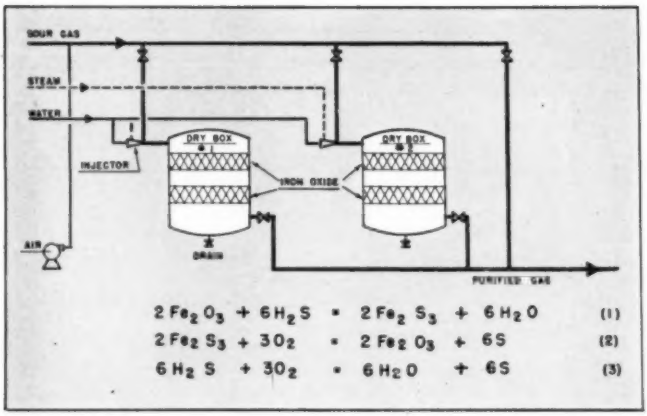
Heat exchange cleaning is "big business" at the Bayway refinery. There are about 800 bundles at the refinery, with approximately 700 in service and 100 as spares. Heat exchange equipment represents an investment of several million dollars. The maintenance and repair program for these bundles is indicated by the following table:

Year	—Total Bundles— Cleaned	Retubed
1947	225	72
1948	272	58
1949	256	44
1950	(Over 300—estimated)	

The above figures represent work done in the shop only, and do not include jobs in the field at the process units.

The new Hydro-Sand Blast unit has been used on a wide variety of metals without apparent loss of metal or tube distortion, including steel, Admiralty, 18-8 Stainless steel, cupro-nickel and other similar alloys. The technique apparently gives an even smoother surface than dry sand blast methods. Tube sizes cleaned with no damage have ranged from $\frac{5}{8}$ to 1½ in., I.D., in gauges from 18-10.

Bayway's installation is believed to be the first to use the high efficiency and great mechanical impact obtainable from sand and high pressure water for cleaning heat transfer equipment. A number of refineries are using straight hydraulic methods with water jets at 800-1000 psi.



$$2Fe_2O_3 + 6H_2S \rightarrow 2Fe_2S_3 + 6H_2O \quad (1)$$

$$2Fe_2S_3 + 3O_2 \rightarrow 2Fe_2O_3 + 6S \quad (2)$$

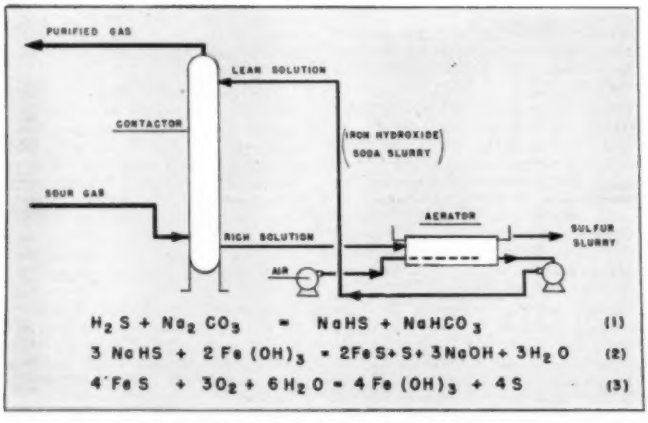
$$6H_2S + 3O_2 \rightarrow 6H_2O + 6S \quad (3)$$

FIG. 1—Simplified flow diagram of the iron oxide, dry box, process for hydrogen sulfide removal, and chemical reactions involved

Selective H_2S Absorption . . .

. . . A Review of Available Processes

The common gas treating systems are reviewed with reference to their use for removing H_2S selectively from gas streams containing appreciable amounts of CO_2. The iron oxide dry box, iron soda and Thylox processes are utilized where essentially complete selectivity is required for H_2S removal. The sodium phenolate, tripotassium phosphate and processes using ethanolamines are representative of partially selective systems. In pilot plant studies of the ethanolamine processes, data indicate that methyldiethanolamine offers considerable promise on the basis of its high acid gas capacity, low steam requirement, good selectivity and high efficiency for H_2S removal.



$$H_2S + Na_2CO_3 \rightarrow NaHS + NaHCO_3 \quad (1)$$

$$3NaHS + 2Fe(OH)_3 \rightarrow 2FeS + S + 3NaOH + 3H_2O \quad (2)$$

$$4FeS + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3 + 4S \quad (3)$$

FIG. 2—Basic cycle of the iron-soda gas purification process

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HYDROGEN sulfide is generally considered to be an undesirable contaminant in natural and refinery gas streams and numerous processes for its removal have been developed. Because of the primary importance of removing this component, however, the effect of the processes upon carbon dioxide and other contaminants has been given little attention. Some of the available processes remove carbon dioxide completely while others allow it to pass through unabsorbed. Since other contaminants such as water vapor, mercaptans, hydrogen cyanide, carbonyl sulfide and carbon disulfide may also affect the treating picture, it is apparent that the determination of the most suitable gas treating process for any specific problem requires more than a simple consideration of hydrogen sulfide removal requirements.

This paper presents brief descriptions of the most common gas treating processes, with particular reference to their use for removing hydrogen sulfide selectively from gas streams which also contain appreciable amounts of carbon dioxide. It also presents pilot plant data on a new process developed specifically for this purpose. Research in this field

* Presented before the Oklahoma State Meeting of the American Institute of Chemical Engineers, Tulsa, Oct. 7, 1950.

has been conducted in response to numerous inquiries describing instances where such a selective process would be of value.

In the case of a natural gas containing relatively little hydrogen sulfide and a large proportion of carbon dioxide, for example, the cost of treating for total acid gas removal may be prohibitive. However, removal of the hydrogen sulfide alone, if this can be done at a proportionately lower cost, may be adequate to produce a marketable product. The problem of acid gas disposal represents a second factor which may make total acid gas removal by a regenerative process disadvantageous in such a case. The high CO_2 vent gas resulting from such a process would require the addition of valuable hydrocarbon to permit combustion in a flare and would not make a suitable feed gas for a sulfur recovery or acid plant.

Other instances where a selective H_2S removal process is desirable include the manufacture of dry ice, where H_2S may be removed from the impure CO_2 product or from the hydrocarbon gas stream prior to CO_2 removal, and catalytic processes involving a gas stream in which a specific amount of CO_2, but no H_2S, is required.

The established chemical systems used to remove H_2S selectively from gases in the presence of CO_2 are based upon either a specific reaction of H_2S to form a sulfur compound which is regenerable by oxidation, or the absorption of H_2S in an alkaline solution in which the rate of absorption of CO_2 is greatly depressed.

Systems of the first type include the iron oxide dry box, the iron-soda, and the Thylox processes. When operated regenerably, the reagents of these processes serve primarily to fix the sulfur of the hydrogen sulfide so that it can be oxidized to elemental sulfur in a second step. Since carbon dioxide does not enter into this type of reaction, the processes are almost completely selective.

The second type of selective absorption is represented by the Seaboard sodium carbonate process, the sodium phenolate process, the tripotassium phosphate process and processes utilizing certain tertiary amines. The selectivity of these processes is due primarily to a considerable difference in the rate of absorption of the two acid gases in mildly alkaline solutions. Hydrogen sulfide is able to react directly and rapidly with the normal salts of weak acids to form bisulfides and either acid salts or free acids, and it is able to react directly with tertiary amines to form amine sulfides and bisulfides. The rate of its absorption is therefore governed by physical diffusion. Carbon dioxide, on the other hand, being the anhydride of an acid, cannot

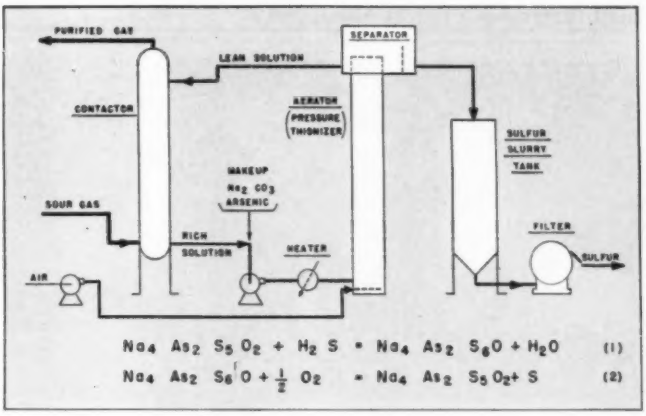

FIG. 3—Simplified flow diagram of the Thylox process

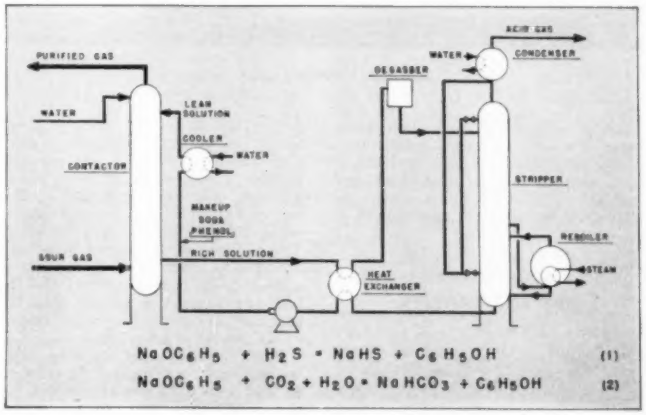

FIG. 4—Single-stage phenolate gas purification process

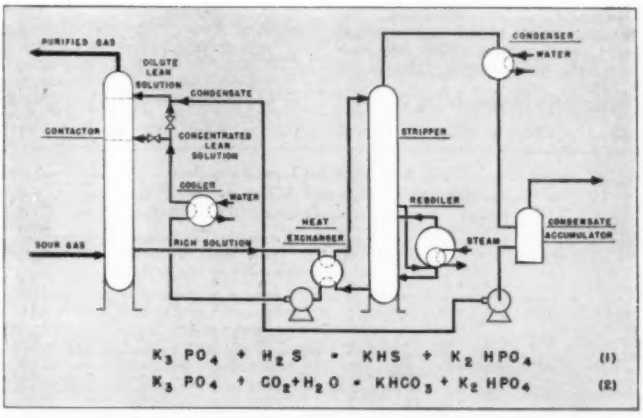

FIG. 5—The tripotassium phosphate gas purification process

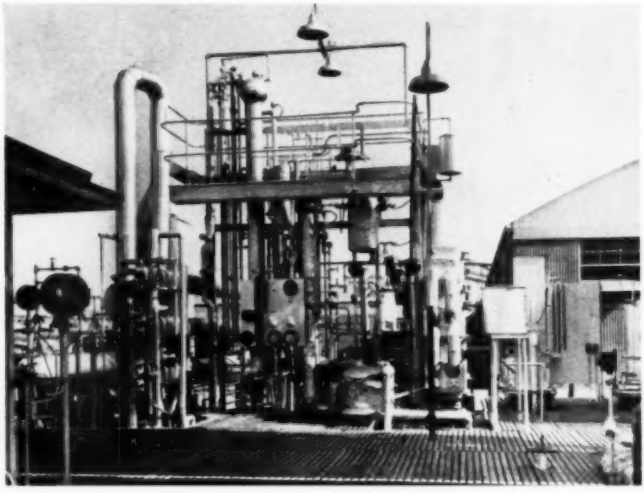

FIG. 6—Gas treating pilot plant

react directly with these compounds and, although the exact mechanism of its absorption is not known, it has been shown by numerous investigators to be governed by a relatively slow chemical reaction.[22]

IRON OXIDE DRY BOX PROCESS

The use of iron oxide in dry boxes is one of the oldest methods for removing hydrogen sulfide from gas streams and is still used to a considerable extent. A simplified flow diagram and the chemical reactions involved in this process are given in Fig. 1. Many forms of iron oxide are used. One of the commonest, iron sponge, consists of iron oxide impregnated wood shavings and may contain from 5 to 10 lbs. of Fe_2O_3 per cu. ft.[21]

Equation 1 represents the initial reaction which occurs and indicates that 1 lb. of iron oxide can absorb a maximum of 0.64 lb. of hydrogen sulfide if no oxidation occurs. In practice, only about one-half of this theoretical value is realized unless air is added to the inlet gas stream.[4] The addition of air causes Reactions 2 and 3 to occur so that the supply of iron oxide is not depleted and the bed may be kept in service until the presence of elemental sulfur causes an excessive pressure drop.

For optimum performance, dry boxes require a temperature between 80 and 100° F., a water content between 30 and 50% of the sponge weight, and the presence of an available potential alkali (as Na_2CO_3). The dry box process is completely selective for hydrogen sulfide with respect to carbon dioxide and hydrocarbons; however, partial conversion or absorption of other compounds as COS, and CS_2 and HCN may occur.

This process has the disadvantages of non-continuous operation, cumbersome equipment and high operating cost. However, it is well suited for the removal of traces of hydrogen sulfide from low pressure gas streams, particularly where the presence of tars, air, CO_2, HCN, NH_3, COS, CS_2 and other contaminants might cause difficulties in the operation of continuous processes which could produce equally sweet gas.

TABLE 1—Pilot Plant Operating Data
Comparison of TEA and MDEA at 585 Psig.

Run No.	Flow Rates: Inlet Gas SCF/H	Solution GPM	Still Reflux GPM	Inlet Gas: % CO_2	% H_2S	Outlet Gas: % CO_2	H_2S Gr/100 SCF	Acid Gas Absorbed (Net): SCF/CF Solution CO_2	H_2S	Total	Mols/Mol Amine	CO_2 Absorbed % of Inlet
				35 Wt. % Aqueous Methyldiethanolamine (3.0 N)								
1.....	1260	0.24	0.05	8.0	0.70	1.8	0.25	30.6	4.74	35.3	0.508	59
2.....	1230	0.19	0.06	9.8	0.70	2.4	0.90	38.3	7.01	45.3	0.635	54
3*.....	1200	0.19	0.06	9.5	0.74	4.1	2.9	32.8	6.49	39.3*	0.555	41
				42 Wt. % Aqueous Triethanolamine (3.0 N)								
4.....	1240	0.28	0.05	6.1	0.64	1.3	0.05	21.2	3.3	24.5	0.368	80
5.....	1210	0.33	0.05	6.3	1.40	2.6	0.10	23.1	6.5	29.6	0.390	61
6.....	1200	0.32	0.05	8.3	1.49	4.7	1.6	22.9	7.1	31.0	0.407	46
7.....	1210	0.33	0.05	12.7	1.35	6.9	8.5	28.0	6.2	34.2	0.475	50
8.....	1220	0.22	0.05	10.2	0.80	6.3	10.5	27.4	5.5	32.9	0.443	41
9.....	1210	0.25	0.05	11.7	0.97	7.7	29.0	28.0	5.8	33.8	0.441	38

* Gas feed to center of absorption column.

IRON-SODA PROCESS

The iron-soda process represents an attempt to utilize the chemical reactions of the iron oxide dry box process in a continuous system. Numerous modifications have been developed; however, the basic cycle as shown in Fig. 2 consists of contacting the sour gas with a dilute solution of sodium carbonate containing suspended iron oxide (or hydroxide) and regenerating the spent solution with air. A recent application of a process of this type has been made to natural gas produced in the Santa Maria oil field of California.[18] In this instance, a selective process was required for H_2S removal as the gas contained a high percentage of CO_2 and it was desired to remove a portion of this CO_2 by monoethanolamine in a later step for the production of dry ice.

The above plant treats gas containing about 34 grains H_2S/100 SCF and 15% CO_2. The H_2S content is reduced to 3 to 4 grains by absorption in the iron-soda solution at about 80 Psig, while the CO_2 content is not appreciably affected. Aeration is carried out in long horizontal troughs. The free sulfur which is formed floats to the top of the liquid and is skimmed off while the reactivated solution is returned to the contactors.

Work done in Russia on this type of process [10, 15, 25] indicates that the optimum concentrations in the liquid are approximately 0.4% Fe $(OH)_3$, 0.6% Na_2CO_3, and 3.0% total alkali (Na_2CO_3 + $NaHCO_3$). Sulfur yields from 70 to 85% of that absorbed have been reported, most of the remaining sulfur forming non-regenerable salts. The product contains about 50% moisture and 20% ash (mostly entrapped $Fe(OH)_3$). H_2S removal efficiencies from 88 to 95% are obtainable.

SEABOARD PROCESS

The iron-soda process described above is actually a modification of the old Seaboard process which uses only sodium carbonate in dilute solution (3%) as the absorbing agent.[24] Regeneration is accomplished by simple air blowing in a separate

TABLE 2—Pilot Plant Operating Data
Comparison of TEA and MDEA at 45 Psig.

Run No.	Flow Rates: Inlet Gas SCF/H	Solution GPM	Still Reflux GPM	Inlet Gas: % CO_2	% H_2S	Outlet Gas: % CO_2	H_2S Gr/100 SCF	Acid Gas Absorbed (Net): SCF/CF Solution CO_2	H_2S	Total	Mols/Mol Amine	CO_2 Absorbed % of Inlet
35 Wt. % Aqueous Methyldiethanolamine (3.0 N)												
1a.....	460	0.24	0.04	14.2	0.30	10.7	0.07	11.3	1.08	12.4	0.177	28
2a.....	450	0.36	0.04	16.9	0.69	10.3	0.22	10.9	0.97	11.9	0.171	44
3a.....	390	0.37	0.04	35.5	0.34	25.5	0.05	16.3	0.66	17.0	0.232	38
44 Wt. % Aqueous Triethanolamine (3.1 N)												
4a.....	400	0.26	0.05	13.8	0.44	8.7	0.9	...	...	11.0	0.149	41
5a.....	420	0.26	0.05	14.7	0.45	8.9	1.6	9.9	0.86	10.8	0.145	44

tower, the hydrogen sulfide-air mixture escaping to the atmosphere or occasionally being fed to a furnace if the H_2S constitutes a serious nuisance. The main reaction involved in the Seaboard process is Equation 1 of the iron-soda process which is reversed in the regenerator. The absorption efficiency of this process for hydrogen sulfide seldom exceeds 90% at low pressures although it increases markedly with pressure. The process is partially selective for H_2S in the presence of CO_2 and absorbs HCN quite completely. It is unsatisfactory for gases containing high proportions of HCN and other contaminants, however, because of the occurrence of side Reactions.[5] This process offers the advantage of simplicity, although its use is not expanding at present because of the low efficiency obtained and the high power requirements.

THYLOX PROCESS

There are about a dozen plants using the Thylox process in the U. S.[16] and several in Europe and Japan. A simplified diagram is presented in Fig. 3. The active ingredients in the solution are various sodium or ammonium thioarsenates with which H_2S reacts to form modifications containing higher proportions of sulfur as shown by Equation 1. Carbon dioxide has practically no effect upon the solution because of its low alkalinity (pH is 8 or less). However, HCN is absorbed quantitatively forming thiocyanates.[9] Regeneration with air yields elemental sulfur which is recoverable as a marketable byproduct.

In typical Thylox plant treating coke oven gas the H_2S content is reduced from approximately 300 grains/100 SCF in the feed gas to 6 to 15 grains/100 SCF in the product gas (an efficiency of 95 to 98%). However, efficiencies as high as 99.7% have been reported.[11] Sale of the sulfur produced approximately balances the cost of the operation in some instances. One large installation (45 MMSCF/D) reports the consumption of 120 lbs. of soda and 5.9 lbs. of white arsenic and the production of 290 lbs. of sulfur per MMSCF of gas. If no credit is taken for recovered sulfur, the operating costs of this process are relatively high, and its complexity constitutes an additional disadvantage over other processes.

PHENOLATE PROCESS

The Phenolate process utilizes a typical heat reactivation cycle as illustrated in Fig. 4 which may, however, be modified to a two-stage system for increased steam economy. The solution, which contains approximately 3 mols of NaOH (120 grams) and 2 mols phenol (188 grams) per liter[23] contacts the gas in one column and is regenerated by heat in a second column. Stripping vapor is provided by volatilization of water from the solution in the reboiler and this is condensed from the acid gas stream and returned to the system. The system is partially selective for H_2S in the presence of CO_2 because of the higher rate of absorption of H_2S. It has been estimated that H_2S is absorbed three times as rapidly as CO_2 by such a solution.[6] In operation with a gas containing equal parts of H_2S and CO_2, it has been found that the gas off the stripper may be more than 90% hydrogen sulfide and less than 10% carbon dioxide.[3]

The capacity of the Phenolate solution for H_2S is quite high, varying up to about 35 SCF/CF for an extremely sour gas, and the gross operating cost (neglecting credits for sulfur or H_2S) is somewhat less than that of the Thylox process for a typical case.[17] The gaseous H_2S byproduct, however, is not as convenient to store and handle as the elemental sulfur produced by the Thylox process, the efficiency of H_2S removal is generally quite low (on the order of 90%) and the steam consumption of this process is very high. A typical plant, for example, to produce an 80-grain product gas from a feed containing 8000 grains/100 SCF has been calculated to require a minimum of about 6.2 lbs. of steam/lb. of H_2S if operated single stage and 3.2 lbs. if operated with two stages.

TRIPOTASSIUM PHOSPHATE PROCESS

The tripotassium phosphate process is quite similar to the sodium phenolate method in that it also utilizes a solution of the weak acid salt of a strong alkali as the absorbing medium in a continuous cycle utilizing heat for regeneration. A typical flow arrangement is shown in Fig. 5. The phosphate solution may also be operated as a partially selective absorbent taking advantage of the more rapid rate of absorption of H_2S than CO_2. However, when operated for maximum selectivity the process will not provide high H_2S removal efficiency and if an attempt is made to obtain good H_2S removal in the presence of CO_2, the circulation rate and steam consumption become excessive.

The basic phosphate process is quite old; however, recent modifications have been developed in the flow system directed toward more efficient operation [14, 19, 27] and a number of plants have been erected. In installations treating refinery gas, the H_2S content may be reduced from as high as 3000 grains/100 SCF to 15 grains/100 SCF with a solution containing approximately 32% K_3PO_4.[13]

For ordinary gas treating operations, the process is not competitive with ethanolamine systems and several installations are known where the phosphate solution has been replaced by amine. This system does have certain features, however, which may make it useful in certain instances. The high stability and non-

Meet the Author

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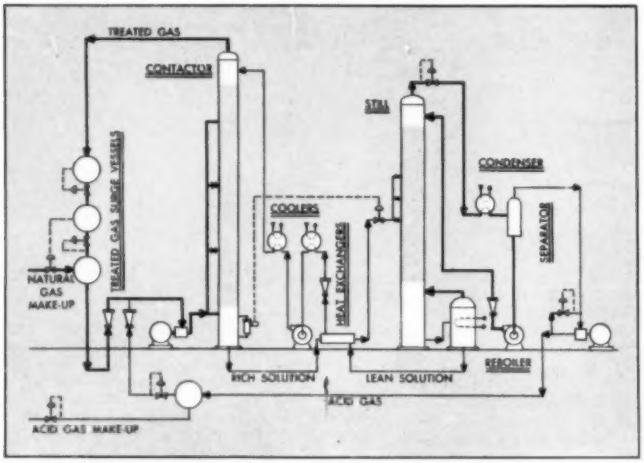

FIG. 7—Flow diagram of gas treating pilot plant

volatile nature of the tripotassium phosphate make it applicable for absorption temperatures as high as 200° F.[18] and for gas streams containing reactive contaminants. Its insolubility in hydrocarbons makes it useful for liquid hydrocarbon treating.

In a recently described liquid treating installation,[26] the H_2S content of the liquefied hydrocarbon gas is reduced from 250 grains/100 SCF to 1.7 grains/100 SCF (an efficiency of 99.3%). Carbon dioxide which is present in the feed to the extent of 0.5% (by volume) is also absorbed by the solution in this case.

AMINE PROCESS

It is probable that in the U. S. more hydrogen sulfide is removed from gases by processes utilizing ethanolamines than by all the other processes combined. The three members of this group most commonly used for gas treating are monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA).

These are, respectively, a primary amine, a secondary amine and a tertiary amine. In the absorption of CO_2 by a primary or secondary amine, a considerable fraction of the carbon dioxide reacts directly with the amine to form a carbamate. The presence of this compound may be indicated by the relatively small precipitate obtained when barium chloride is added to such a solution. With tertiary amines, however, this reaction cannot take place and the much slower path to the carbonate must be followed.

For similar conditions of absorption in a packed column, it has been shown that the overall coefficient (K_ga) for the absorption of carbon dioxide in solutions of TEA is on the order of one-tenth of that for DEA and one-twentieth of that for MEA.[20] The data of Bottoms[2] indicates that the initial rate of absorption of H_2S in a 50% TEA solution is approximately 5 times that of CO_2 under comparable conditions.

MEA is generally used for treating natural gas for carbon dioxide recovery processes. Extremely high efficiency hydrogen sulfide removal is obtainable with this amine; in fact, solutions of MEA in diethylene glycol and water frequently produce gas containing less than 0.05 grain of H_2S/100 SCF from feed gases containing several percent.[12] In such operations, essentially complete carbon dioxide removal is also obtained; however, in certain instances where less complete hydrogen sulfide removal is acceptable, MEA plants can be operated to pass a small fraction of the carbon dioxide. One commercial installation, for example, treating a gas containing 3½% each of H_2S and CO_2 at 40 Psig. with an aqueous solution of MEA passed approximately 10% of the CO_2 when operated to produce 5 grain gas.

DEA finds considerable application to the treatment of refinery cracked gas streams where its resistance to decomposition by COS and CS_2 and low volatility give it an advantage over MEA; however, it is not as efficient as MEA for the removal of either H_2S or CO_2, nor is it particularly selective. Its primary advantages over the phenolate and tripotassium phosphate processes in this service are generally lower steam consumption and solution circulation rate.

TEA was the first of this series to find application for gas treating[1] and its property of partial selectivity was recognized early. The poor efficiency of this amine with regard to H_2S absorption and its very high molecular weight have caused it to be replaced by MEA and DEA for most gas treating applications.

PILOT PLANT OPERATIONS

In order to evaluate the selectivity of TEA under various conditions and to compare it with methyldiethanolamine (MDEA) which has recently been proposed as a selective absorbent for hydrogen sulfide,[7] pilot plant operations have been conducted with solutions of the two amines under similar conditions.

A photograph of the pilot plant used for these operations is shown in Fig. 6. The contactor, which is the column on the left, consists of a length of 4 in. steel pipe containing an 11 ft. section of ⅝ in. porcelain Raschig ring packing. The still shown on the right is made of 6 in. pipe and contains about 7 ft. of packing with the liquid feed point approximately 3 ft. from the top. A flow diagram of the pilot plant is shown in Fig. 7. It will be noted that the acid gas and purified gas streams as well as the solution are recirculated. Although this makes exact control of the inlet gas composition rather difficult, due to the presence of CO_2 in the overhead gas, it greatly reduces the consumption of hydrocarbon and acid gases and eliminates the problem of disposal of the still overhead gas stream.

Table 1 presents comparative data on pilot plant operations with equivalent solutions of TEA and MDEA at 585 Psig. The operations with TEA were conducted so that data could be obtained under conditions required to produce gas varying from very sweet (0.05 grain/100 SCF) to very sour (29 grains/100 SCF) with regard to H_2S content. It was observed that the quantity of CO_2 absorbed varied from 80 to 38% of the inlet volume during this series, while the total quantity of acid gas absorbed varied from 24.5 to 33.8 SCF/CF of solution. Although the inlet gas composition varied appreciably during the series of runs, the above variables appear to follow a definite pattern which is illustrated in Fig. 8.

A characteristic of such systems is that as the solution loading is increased (by decreasing the solution rate or increasing the acid gas rate) a point is reached above which the H_2S content of the product gas increases very rapidly. In the case of the TEA operations presented in Fig. 8, this apparently occurs at approximately 30 SCF of acid gas absorbed/

CF of solution circulated. A feasible value for commercial operation might be 28 SCF/CF, at which point approximately 70% of the CO_2 is absorbed and a gas containing 0.25 grain H_2S/100 SCF is produced.

Two runs with an equivalent MDEA solution are also represented on the diagram. The curves for these runs are considerably to the right of those for TEA, indicating that a lower solution circulation rate would be required. A comparable commercial unit using MDEA could probably be operated to absorb 35 SCF of acid gas/CF of solution and would remove about 60% of the CO_2 while producing 0.25 grain gas. This represents a solution circulation rate approximately 30% less than required for the TEA solution.

For purposes of comparison, it is interesting to note that the H_2S curve for an MEA solution of equivalent normality would break upward at a solution loading of approximately 25 SCF/CF; however, as this represents a solution containing only about 18% amine, it does not indicate maximum capacity of MEA solutions.

Run 3 in Table 1 was included to show the effect of shortening the contact height. The operating conditions of Run 2 were maintained and it was found that the CO_2 absorption dropped from 54 to 41% while the H_2S content of the outlet gas increased from 0.9 to 2.9 grains (a drop in efficiency from 99.8 to 99.4%)

Table 2 compares data obtained at a contact pressure of 45 Psig. with inlet gas compositions varying from 0.2 to 0.7% H_2S and from 13.8 to 35.5% CO_2. In the three runs with MDEA, CO_2 absorption efficiencies from 28 to 44% were obtained, while in each case the outlet gas contained less than 0.25 grain H_2S. With the TEA solution at this pressure, sweet gas could not be obtained although operations were conducted so that 41 to 44% of the CO_2 was absorbed. As in the high pressure operations, the MDEA solutions absorbed considerably more acid gas per unit volume than the equivalent TEA solutions.

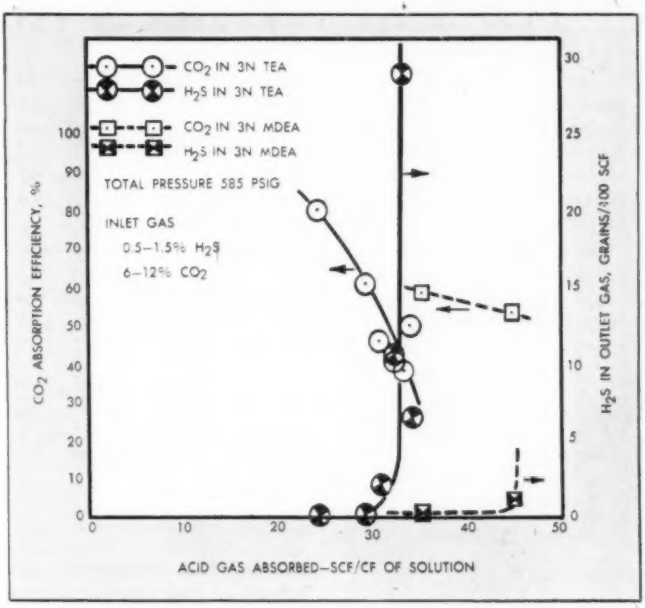

FIG. 8—Comparison of pilot plant operations with TEA and MDEA

CONCLUSIONS

The general trend in the treatment of refinery and natural gas streams appears to be toward the use of ethanolamine solutions, although iron oxide dry boxes find some application for the removal of very small quantities of H_2S from gases and the phenolate and tripotassium phosphate systems may be useful under certain conditions.

Where essentially complete selectivity is required for H_2S removal in the presence of CO_2, three of the systems considered in this paper may be utilized. These are the iron oxide dry box process, the iron-soda process and the Thylox process. It is probable that the first of these would be preferable for small quantities of H_2S, the second for intermediate quantities and the third for large quantities where a marketable amount of elemental sulfur would be produced.

For installations where a partially selective process is adequate or preferable, the heat reactivated systems using sodium phenolate, tripotassium phosphate, triethanolamine or methyldiethanolamine may be utilized. Laboratory and pilot plant research indicate that the last mentioned compound offers considerable promise on the basis of its high acid gas capacity, low steam requirement, good selectivity and extremely high efficiency for H_2S removal.

Experimental work described in this paper was performed by the Research and Development Department of the Fluor Corp., Ltd. under the direction of Messrs. Ira C. Bechtold and C. L. Blohm. Their contributions and the assistance of various members of the research staff are gratefully acknowledged.

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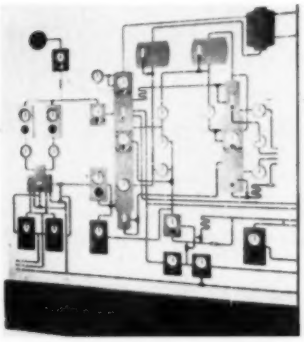
TOPS in "WHAT'S NEW!"–1950

During the year just finished, Petroleum Processing's readers have indicated high interest in virtually all the new products, new materials, new equipment, and new literature reviewed in the monthly "What's New!" section. Interest in some items, of course, has outstripped the others.

As a service to those readers who might have missed these items the first time, may not have been with us before, or may now find them of value in their daily work, the editors have assembled on these two pages the "Tops in What's New!–1950," repeating the reviews of the most interesting products published last year.

A code number has been assigned to each item. Readers are invited to use the Reply Cards, which they will find between pages 80 and 81, to request further details or copies of trade literature.



Two New Graphic Instrument Panels Effect Substantial Space Savings

The Brown "Grafic" and "Color-Grafic" instrument control panel boards, soon to be made available to the refining industry, represent the latest entry into this rapidly growing field of automatic and simplified instrumentation for petroleum and chemical processing plants. The panel design, developed in cooperation with a leading refinery contracting engineering firm and the Henry Dreyfuss organization of industrial designers, involves an efficient use of color, arrangement, and symbols. In general it follows the concepts of other recently announced graphic panels, employing the small size gages and remote setting controllers. The standard "Grafic" panel (shown in the photograph) incorporates all instruments within the flow diagram. In the Color-Grafic, fuller use of color is made and all controllers are mounted below rather than on the flow diagram. In this way a sizable reduction in board length is attained. A color and symbol code ties in the controllers with the various points in the process. Comparative reduction in board length, it is stated, is about as follows: from 45 ft. in the conventional panel to 19 ft. with the Color-Grafic, and 24 ft. 4 in., in the Grafic. Brown Instrument Co.

Circle No. **1** *on Reply Card*

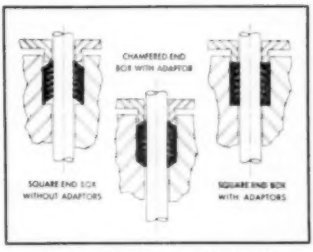
Slide Rule Flash Calculator Described In Petroleum Processing Now Available

The Blaw-Knox slide-rule type, equilibrium flash calculator rapidly solves flash calculations which involve the determination of the quantity of each component in a given hydrocarbon mixture existing in the liquid and vapor phases under different conditions of temperature and pressure. The development, uses, and advantages of the tool were described in PETROLEUM PROCESSING, September, 1950, pages 948-949. It is intended primarily as a time-saver, and can be used either for final solutions with an accuracy of plus or minus 1%, or for preliminary approximations when greater accuracy is needed. Decimal points are located automatically over the wide range of values normally encountered. It may be purchased, complete with operating instructions, at $2.50 postpaid. Chemical Plants Div., Blaw-Knox Construction Co.

Circle No. **2** *on Reply Card*

Cone-Type Teflon Packing Gives High Chemical Resistance and Low Friction

A Cone-type "Teflon" packing has been developed for use in stuffing boxes where the application demands complete resistance to chemical attack and where the packing must allow a freely operating spindle. Called "Chemiseal No. 810C", the packing is formed entirely of Teflon and is completely inert to all chemical action at temperatures from −150 to 550° F. It is supplied as a series of cone-shaped rings in which the sealing action is derived partly from the flexing of the cones and does not depend entirely on deformation. Because less pressure is needed to cause the flexing, than is required to deform a conventional packing, low gland pressure is sufficient to maintain a seal yet create minimum friction, thus allowing free spindle operation. The packing is supplied in sets to meet specified requirements, and is available with adaptors for either square-end or chamfered-end stuffing boxes. If necessary, the cone-shaped rings may be split for installation. United States Gasket Co.



Circle No. **3** *on Reply Card*

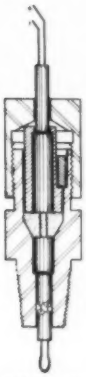
Obtain Efficient Caustic Regeneration By Filter Press-type Electrolytic Unit

Regeneration of caustic employed in sulfur removal operations in the refinery can be done electrolytically by a new process which is still in the patent pending stage. The process, it is said, will overcome problems in existing caustic regenerators; for example, the return regenerated caustic stream may contain up to 70% of the mercaptans, and the hydrogen sulfide getting by the preliminary scrubber may be so high as to require discarding the caustic every month. Operation of the electrolytic procedure follows: Spent caustic from the gasoline scrubber is passed through a filter press-type electrolyzer, the alternate plates of which are charged by direct current. The plates are separated by insulating diaphragm plates. The flow through the thus-formed cells is adjusted so that no excess oxygen is liberated. The hydrogen liberated at the cathode plates is either collected in a reservoir or allowed to pass through with the caustic and collected at a separat-

ing tank into which the electrolyzed caustic stream is passed. In the separator, the insolubles, mostly disulfides, are drawn off from the upper phase and the regenerated caustic is recycled to the scrubber. Semi-plant tests with a small commercial electrolyzer have shown the power consumption is about 0.6 lbs. sulfur removed per kwh. at ambient temperature. American Development Co.

Circle No. **4** *on Reply Card*

Thermocouple Gland Takes Bare Wire Couples with no Leakage Problems



The "Conax" thermocouple gland is designed to provide the accuracy and quick response of bare wire thermocouples without the leakage and expense usually associated with this method when used on closed vessels under pressure or vacuum. Wires are sealed by compressing dry powdered talc between the two ceramic insulators so as to be unaffected by temperatures or chemical reaction. The gland may be used at temperatures from −100 to +1600° F. and pressures up to 400 psi. Body and caps are made of Type 304 stainless steel. Gland follower and key, which do not come in contact with gases, vapors, or liquids, are made of high quality tool steel. Glands are available in models for standard 20-gage thermocouple wires, 14-gage thermocouple wires, and for use with terminal block or conduit. Conax Sales Co., Inc.

Circle No. **5** *on Reply Card*

New Tubing Fittings Stop All Leaks In Instrument Line Connections

Small leaks in instrument lines can be completely eliminated by using "Swagelok" fittings, according to the manufacturer. A vacuum tight seal is provided by the two ferrules and the threaded chuck inside the nut which clinch tight around the tubing wall. Tests have shown the tubing will burst before the fitting will leak. The fittings will hold heavy or thin wall tubing. They are made for use with aluminum, brass, copper, steel, stainless steel, or plastic. No

flaring of the tube is necessary in assembly. Fittings are available in brass, Monel, aluminum, steel, and stainless steel, in a range of sizes for tubing ⅛ to 1 in. O.D. Crawford Fitting Co.

Circle No. **6** *on Reply Card*

Describes 31 Refining Processes

Petroleum Horizons, an 80-page book giving a step-by-step description and flow sheets for 31 refinery processes, plus details on the background, organization, and service facilities of the Lummus Co.

Circle No. **7** *on Reply Card*

Gas Compression Data

Compressibility Charts and Their Application to Problems Involving Pressure-Volume-Energy Relation for Real Gases, Bulletin P-7637; a Worthington Research Bulletin. Worthington Pump and Machinery Corp.

Circle No. **8** *on Reply Card*

High Temperature Steels

Steels for Elevated Temperature Service, 87-page book, illustrated, with complete engineering and technical details on ferrous alloys used in all high temperature applications such as petroleum and chemical processing, power, transportation, and jet, rocket, and turbine engines. United States Steel Corp.

Circle No. **9** *on Reply Card*

Refinery Paint Manual

Petroleum Refinery Paint Manual; 55 pages, indexed, leatherette bound booklet designed as a comprehensive guide for the painting of refineries and refining equipment; including suggestions for surface preparation, a recommended painting schedule for both interior and exterior surfaces, miscellaneous notes on painting, and application properties of the products recommended. Socony Paint Products Division, Socony-Vacuum Oil Co., Inc.

Circle No. **10** *on Reply Card*

Data on over 1000 Kinds of Atoms

Chart of the Nuclides, a heavy paper wall chart measuring 26 x 50 in., printed in checkerboard fashion, giving full information on each of the 96 elements and their isotopes; including such data as the proportion of each isotope that normally constitutes the natural element; if radioactive, the speed at which it decays and the radiations emitted; whether it appears as a product of the fission of Uranium 235; and the thermal neutron absorption or activation cross section; includes an explanatory booklet, *Nuclides and Isotopes.* General Electric Co.

Circle No. **11** *on Reply Card*

Valve-sizing Charts

Gas Valve Sizing Chart and *Liquid Valve Sizing Chart,* Supplement Two, Catalog 70; a single-page folder covering the ranges 0.02 to 10,000 gpm. and 1 to 100,000 lbs./hr.: the liquid valve chart takes into account the difference between pressure drop across the valve and across valve ports alone, viscosity, and specific gravity in determining port area and valve size: the gas valve chart takes into account inlet and outlet absolute pressures, gas specific gravity, and temperature. Fischer & Porter Co.

Circle No. **12** *on Reply Card*

Caustic Soda

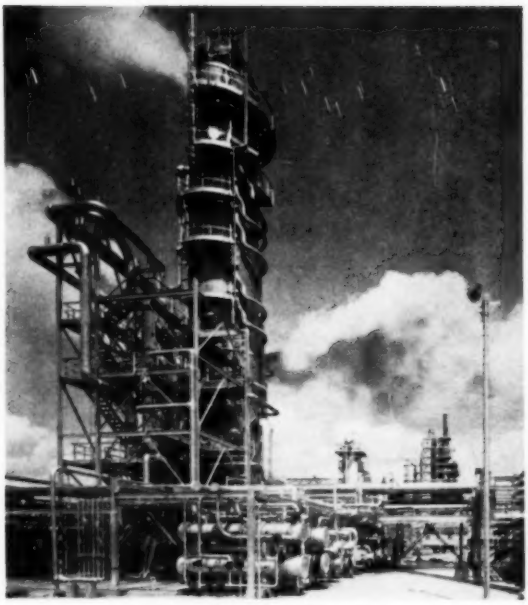
Mathieson Caustic Soda, a 48-page book covering all phases connected with the manufacture, economics, properties, handling, and application of this product. Mathieson Chemical Corp.

Circle No. **13** *on Reply Card*

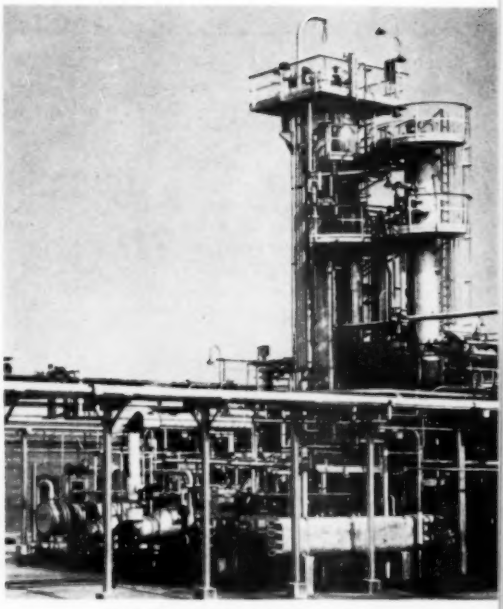
Solvent Extraction

The Practical Way of Solvent Extraction, Bulletin No. 12; presents a complete description of the new patented York-Scheibel Liquid-Liquid Extraction Equipment, comparing it with fractional liquid extraction and fractional distillation for such applications as solvent refining of lube oils, and the like. Otto H. York Co.

Circle No. **14** *on Reply Card*



VACUUM DISTILLATION UNIT



PROPANE DEASPHALTING UNIT

Newest Solvent Lube Plant

Standard Oil Co. (Ohio) last summer completed and put on stream the latest and newest solvent lubricating oil manufacturing plant.

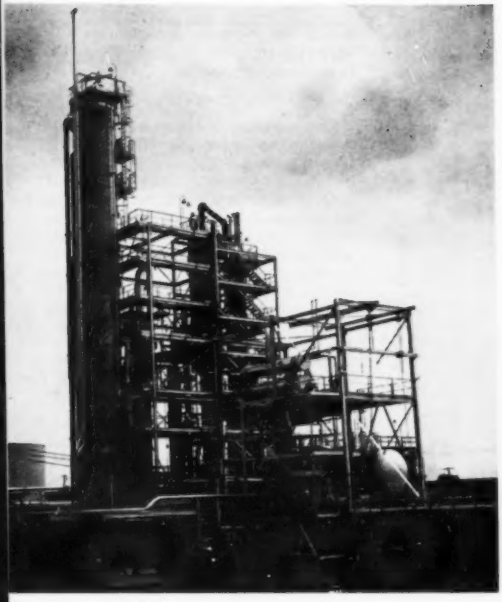
It is located at the company's Lima, Ohio, refinery, cost $13,000,000, and has a capacity of 1,800 b/d of finished oils and base stocks.

Being one of the last solvent lube plants to come on stream in this country, Sohio engineers feel that this has enabled them to take advantage of recent technological developments in the field. As a result, Sohio's plant contains many design innovations which may not be found in other lube plants.

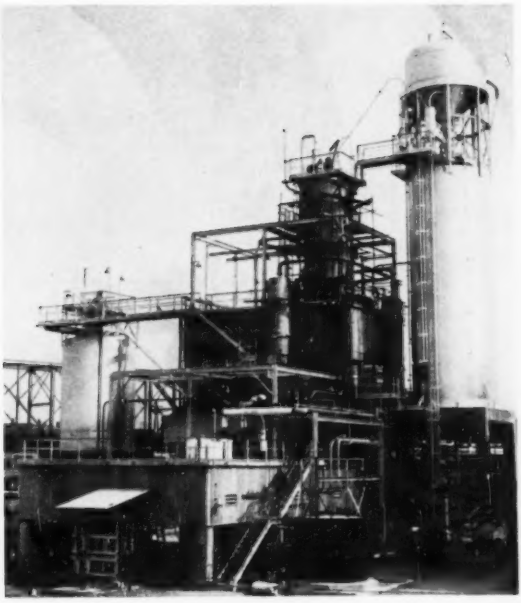
This article is intended to discuss some of these new developments, rather than to dwell on conventional aspects of design.

THIS MONTH'S COVER PICTURE

shows the MEK filter house at Sohio's new lube plant. The building houses three GATX rotary filters on the second floor, with provisions for a fourth, and wax pots, wash drums and pumps on the ground level. The open type construction, a bit unusual in northern refineries, where temperatures sometimes get down to zero or lower, was employed for safety reasons—to "air condition" the building and prevent accumulation of explosive propane mixtures. Besides the omission of the lower section of transite siding, the second floor is composed of open grids to permit free air circulation. The large openings in the upper section of the wall provide ample space for moving the filters themselves in or out of the structure whenever necessary.



FURFURAL EXTRACTION UNIT



CLAY CONTACTING UNIT

Some Unusual Features—

CIRCULATING REFLUX SYSTEM in the vacuum distillation tower, designed for complete condensation of all hydrocarbon vapors reaching the top tray. This system eliminates the need for overhead gas oil condensers, with their attendant high pressure drop.

HEAVY BRIGHT STOCK PRODUCT, with a viscosity of 250 SSU at 210° F. Sohio engineers claim this is the heaviest solvent refined bright stock in the industry, and that it has high load bearing characteristics and high wearing properties.

USE OF TOLUOL INSTEAD OF BENZOL in the MEK dewaxing solvent mixture. Aside from the processing advantages of toluol, the complete replacement of benzol with toluol reduces the number of components to be stored and handled.

HOT BELT HEATING SYSTEMS for both the furfural extraction and the MEK dewaxing units. These closed circulating systems supply all heat requirements of these units, and are the first such systems ever designed by Lummus for lube plant service. They avoid any detrimental effect on the oil of the high skin temperatures usually encountered in the tubes of fired heaters.

PNEUMATIC FEEDING DEVICE for adding clay to the oil charge in the clay contacting unit. This new system, applied commercially for the first time in Sohio's plant, controls clay feed within 5% of the desired rate.

PROVISION FOR EXPANSION to 133% of present capacity. This increase can be achieved without replacing any existing equipment—merely by adding separate units of equipment.

A Plant Description—

By GEORGE L. LUPFER
Refining Control Division
Standard Oil Co. (Ohio)

SOLVENT refining facilities for lubricating oil manufacture were recently placed in operation at Sohio's Lima, Ohio, refinery.

The new lube plant includes vacuum distillation for feed stock preparation, propane deasphalting, furfural solvent extraction, MEK dewaxing, and clay contacting units.

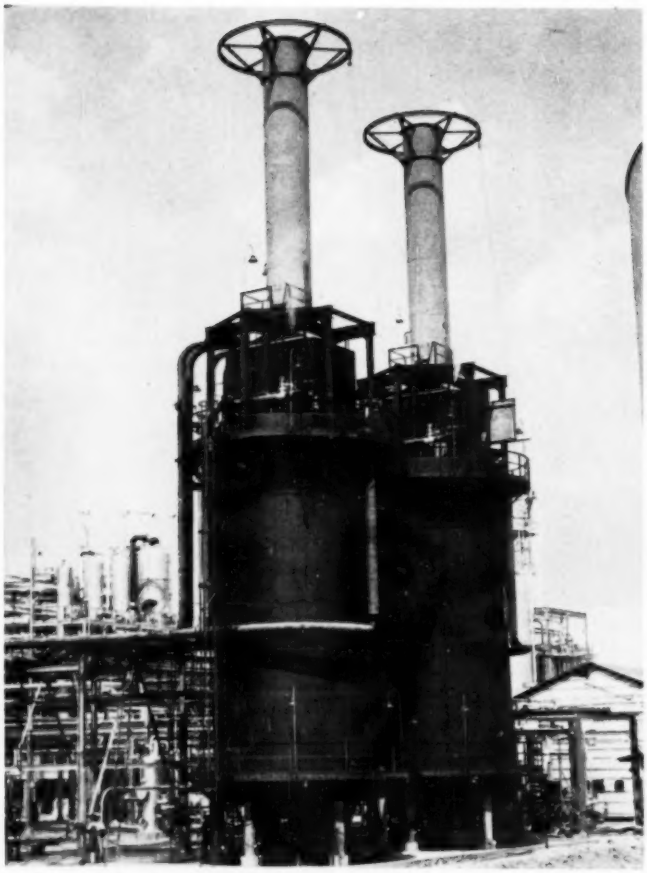
In addition, a new tankfield has been built containing 52 separate tanks for storage and blending of stocks and finished oils. Total capacity is nearly 400,000 bbls.

The plant is designed to process four separate feed stocks to a finished viscosity index and a final pour point which will meet Sohio specifications with only minor quantities of additive

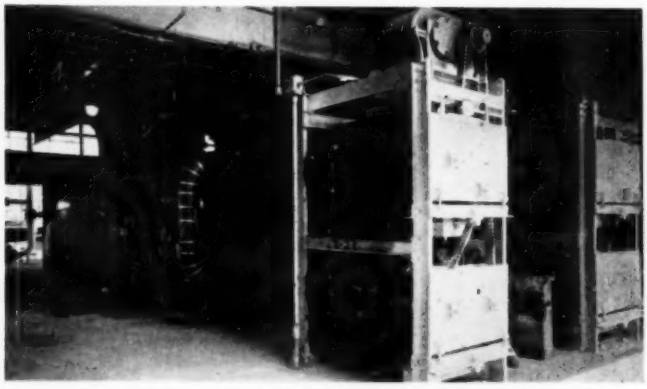
All of the units were designed and built by the Lummus Co., with the exception of the deasphalter, which M. W. Kellogg Co. handled.

All design and construction work on the entire project was closely checked and supervised by Sohio's process and mechanical engineering divisions under the direction of Dr. F. J. Sanders, Technical Manager for the company.

One unique feature of the Sohio design is its ready expandability to higher capacities. This plant has been specifically designed to permit direct expansion to 133% of its present capacity. This expansion is to be accomplished by the addition of separate units of equipment to the plant and without the replacement of any of its present equipment. Thus Sohio has designed a lube plant sufficiently large for today's require-



HOT BELT HEATERS provide all the heat requirements for the furfural extraction, MEK dewaxing, and clay contacting units. Each furnace has a capacity of 50,00,000 Btu/hr., burns either gas or oil



DEWAXING CHILLERS are Vogt nested-type, double-pipe. Each section contains seven 6-in. tubes inside a single shell filled with propane refrigerant. Wax deposits inside the tubes are removed by rotating scraper blades, driven by a chain drive visible at the near end of the chillers

ments but capable of being readily expanded in order to keep step with future sales demands.

Vacuum Distillation Unit

The vacuum distillation unit was designed to charge a 40% reduced Illinois crude. This unit separates the charge into an overhead gas oil product, a bottom short residue product (approximately 11.0% on Illinois crude), and three sidestream products. The three sidestream products, paraffin distillate, intermediate distillate, and vacuum cylinder stock, are stored in tankage for individual feed to the furfural extraction, MEK dewaxing, and clay contact units. These three feed stocks finish with viscosities respectively of 140 SSU @ 100° F., 300 SSU @ 100° F., and 78 SSU @ 210° F.

The heaviest distillate sidestream produced, 78 SSU @ 210° F., corresponds to a finished SAE 40 oil. Recovering all heavier oils by propane deasphalting avoids the possible harmful effect of higher distillation temperatures.

The vacuum tower is 90 feet high and 15 feet in diameter. It contains four bubble cap trays below the flash zone for stripping the bottom product. Immediately above the flash zone are two bubble cap trays for entrainment separation. Above this are located 22 shower trays and one additional bubble cap tray at the very top of the tower. Shower trays reduce the pressure drop through the tower and thus permit lower flash zone and furnace temperatures.

The vacuum tower pressure is further minimized by the use of a circulating reflux system at the top of the tower. Total condensation of the gas oil is obtained in this section, thus eliminating the necessity for overhead gas oil condensers with their attendant high pressure drop. Only steam vapor and non-condensables are taken over the top of the tower to a barometric condenser.

Lummus engineers developed a unique double-reflux system for this tower in order to preserve a high temperature level in the main circulating reflux stream. A high temperature level was desired in order that the main circulating reflux might be used for heat exchange with cold crude. To accomplish this, a secondary reflux system was installed on the top tray to condense the lightest 10 to 20% of the gas oil product. By preventing this light gas oil from returning to the lower reflux system, a higher circulating temperature is maintained.

Lummus and Sohio engineers also devised a method of measuring and controlling the liquid runback to the flash zone. A total drawoff pot is located on the tray immediately above the flash zone. The liquid drawn off at this point is measured in a record-

ing type rotameter and returned to the top stripping tray below the flash zone. This runback quantity may be controlled either by adjustment of the furnace outlet temperature or by regulation of the lower sidestream drawoff rate. Control of this runback is important, Sohio feels, because too small a quantity of runback permits coking to occur on the clean-up trays and causes potential asphalt entrainment. Too much runback, on the other hand, indicates overflashing in the flash zone and unnecessarily high furnace outlet temperatures.

Propane Deasphalting Unit

The propane deasphalting unit was designed to charge vacuum unit bottom product. From this charge deasphalted cylinder stock is produced. This material, together with the three sidestream products from the vacuum unit, constitute the four basic charge stocks to the remaining lube plant units.

The deasphalting tower operates at a pressure of 335 psig., a bottom temperature of 120° F., and a top temperature of 130° F. A total propane-to-oil ratio of 8:1 is employed. The propane used in this unit is obtained from a new LPG plant located in another part of the refinery.

After extraction, dewaxing, and contacting, the deasphalted cylinder stock finishes to a heavy bright stock with a viscosity of 250 SSU @ 210° F. Sohio engineers claim that this is one of the heaviest solvent refined bright stocks in the industry. Pilot plant work has indicated that this heavy bright stock possesses extremely good lubricating characteristics.

Furfural Extraction Unit

The furfural extraction unit has been designed to charge the different fractions from the vacuum and PDA units at varying furfural-to-oil ratios. By the addition of heat exchange surface and spare pumps, this unit is directly expandable to a higher ultimate charging capacity. This ultimate capacity represents 133% of the present unit design.

The main extraction tower is 110 feet high and 10 feet in diameter. This tower is packed with one-inch Raschig rings, located in nine separate beds spaced throughout the tower. Temperature control in this tower is achieved by means of two separate inter-cooler systems. Each system removes liquid from the tower, pumps it through a water cooled exchanger, and returns the liquid to the tower at a point just below the original drawoff nozzle.

The raffinate recovery system consists of a single combination flash tower and stripping column which uses superheated steam for stripping and operates at a pressure of 100 mm. Hg abs.

The extract recovery system contains three separate towers: an atmospheric flash tower, a 30 psig. pressure flash tower, and a vacuum stripping column operated at 100 mm. Hg abs. pressure. In this recovery system the multiple stage evaporator principle is used for heat economy. The overhead vapors from the pressure flash tower are condensed in heat exchangers which preflash the feed to the atmospheric flash tower. Total heat requirements are reduced nearly 50% by this design.

A novel feature of the furfural extraction unit is a circulating hot oil system which is used to supply all of the heat requirements of the unit. Lummus engineers designed this hot oil system, or "hot belt" as it has been called, to replace the fired heaters normally included in the raffinate and extract recovery systems. This design was requested by Sohio in order to avoid any detrimental effect on the oil of the high skin temperatures existing in the tubes of a fired heater.

The hot belt employs a fired heater to heat a circulating gas oil stream to 575° F. This hot gas oil flows through heat exchangers in the furfural extraction unit where its heat is transferred into the raffinate-mix and extract-mix streams. After leaving these exchangers, the gas oil returns to a surge drum, from which it is pumped back through the heater again. The fired heater, a cylindrical, bottom-fired, vertical tube heater, has a design heat duty of nearly 50,000,000 BTU per hour. The convection section of this heater is used to superheat all of the stripping steam used in this unit. This hot belt is one of the first such systems ever designed by Lummus for use in lube plant service.

MEK Dewaxing Unit

The MEK dewaxing unit has been designed to charge the different raffinates produced at the furfural unit. By the addition of heat exchange surface, double-pipe exchanger and chiller units, and an additional dewaxing filter this unit is directly expandable to an ultimate charge capacity representing 133% of the present unit design.

The solvent mixture employed in this unit is 38% by volume methyl-ethyl-ketone and 62% by volume toluol. While the original unit design had included benzol in the solvent mixture, the final design completely replaced this benzol with toluol. This change was made because of recent toluol price reductions. At nearly equal purchase prices toluol has several advantages over benzol, including a lower melting point, higher filtering rates, and reduced toxicity. In addition there is the advantage of storing, handling, and mixing only two components instead of three.

The unit contains five double-pipe exchangers and five double-pipe chillers. Each exchanger and each chiller has a heat exchange area of 875 sq. ft. Three General American rotary dewaxing filters are included, each with a surface area of 625 sq ft. Space has been reserved for the future addition of one double-pipe exchanger, one double-pipe chiller, and one filter.

Both of the solvent recovery systems employ the multiple stage evaporator principle for heat economy. The dewaxed oil-solvent mixture is charged first to an atmospheric flash tower, next to a 30 psig. pressure flash tower, and last to an atmospheric stripping column. The solvent vapors from the pressure flash tower are condensed in heat exchangers which vaporize solvent in the charge to the atmospheric flash tower. The wax-solvent mixture is processed through a similar set of three solvent recovery towers in the same manner. As was the case in the furfural extraction unit, total heat requirements for solvent recovery are reduced nearly 50% by this design.

The refrigerant used in this unit is propane. A steam turbine-driven centrifugal compressor is used to recompress the propane vapor. A novel feature is the use of a combination condensing and extraction type turbine. The turbine is operated with 100 psig. saturated steam. When operating at design capacity, from 10,000 to 65,000 lbs. per hr. of 25 psig. steam may be extracted from one of the turbine stages. The remaining steam passes through other turbine stages and into a surface condenser. The extracted 25 psig. steam is used

Meet the Author

George L. Lupfer, group supervisor, Economics, in Sohio's refining control division, joined the company in 1941 as a junior engineer immediately after graduation from Kansas University with a B. S. in Ch. E. His duties have covered technical service and process engineering work in Cleveland, Toledo, and Lima, including detailed process design since 1948 on the new Lima lube oil plant.

to supply all of the requirements for process steam in all five lube units and in the lube stock tankfield. Much of the process steam is used in suction heaters in the tankfield. As this service is subject to wide seasonal fluctuations, it is calculated that the total demand for process steam will vary throughout the year from 20,000 to 60,000 lbs. per hr. The propane compressor turbine has been designed to supply all of this process steam demand.

Another novel feature of this unit is the use of Vogt nested-type double-pipe chillers. Each chiller section consists of a single shell inside of which are located seven six-inch tubes. Each tube contains a rotating scraper blade to keep the tube walls free from wax deposits. The entire shell is filled with propane refrigerant, immersing all seven tubes. Each chilling unit consists of two such shells with a total of 14 tubes. The scrapers inside of all 14 tubes are turned by means of a chain-drive from a motor located on top of the assembly. Propane liquid is introduced on level control to keep the shells filled. Vapors from these shells pass into a disengaging drum above the chiller. Any entrained liquid propane flows by gravity back into the chiller shells. Temperature control is maintained by a control valve in the vapor outlet from the vapor disengaging drum, which exerts a back-pressure on the chiller shells and thus controls the vaporizing temperature of the propane.

Heat requirements for the MEK dewaxing unit are supplied by a hot belt identical in design to that located in the furfural extraction unit. Again, the purpose of this hot belt is to prevent any detrimental effect of high skin temperatures in a fired heater on the dewaxed oil.

Both the furfural extraction and MEK dewaxing units are operated from a combined master control room. In this control room is located a console type, graphic control panel. This console panel is more fully described in an earlier article in this magazine (July, 1950).

In addition to dewaxing four furfural raffinates the MEK dewaxing unit also produces two steam refined oils. These oils are produced by dewaxing a charge of either raw vacuum cylinder stock or raw deasphalted cylinder stock. The finished steam refined oils have viscosities of 100 and 350 SSU @ 210° F. respectively. Intermediate steam refined oils may be produced by blending these two products in the proper proportion.

Clay Contact Unit

The clay contact unit was designed to charge the different dewaxed oils produced at the MEK dewaxing unit. Clay dosage may be varied as required to give desired product colors. Contact temperatures are attained by means of heat exchange with hot belt oil from the hot belt heater in the MEK dewaxing unit. The objectionable feaures of a fired heater are therefore eliminated in this unit also.

A novel feature of this unit is the method by which the contact clay is added to the oil charge. This method is a recent development of the Lummus Co. and finds its first commercial application in the Sohio plant. Contact clay is stored in a 200-ton fresh clay bin. From this bin it is carried by dry air to a head tank located slightly above the fresh clay bin. Flue gas then picks up the contact clay leaving the bottom of the head tank and transports it to the main contact tank where an oil scrubbing chamber disengages the clay from the flue gas. The control devices employed in this pneumatic system are extremely simple and provide control of the clay rate within 5% of the desired figure. A detailed description of this clay handling system will be given in an article now being prepared for publication in a later issue of PETROLEUM PROCESSING.

Oil charge stock is heated by heat transfer with finished product and with hot belt oil and is then introduced directly into the main contact tank. The clay-oil slurry from the contact tank flows by gravity into a rotary precoat filter. This new type of clay addition is claimed to possess two distinct advantages. It provides more accurate measurement and control of the clay used and it eliminates the necessity of operating pumps in clay slurry service. Flue gas is employed in the final clay transfer to prevent air oxidation of the oil at high temperature in the contact tank.

The oil from the clay contact unit passes through a drying tower where a pressure of ›20 mm. Hg abs. is maintained. In this tower final traces of water are vaporized and removed. The dry oil then flows through a final blotter press to insure the complete removal of clay particles.

Tankfield

Sohio's lube oil tankfield is unique in several respects. The great bulk of tank storage occurs either as furfural feed stock storage or as finished stock storage. Except for small surge tanks, no storage exists for raffinates produced by the furfural extraction unit or for dewaxed oils produced by the MEK dewaxing unit. This means that, when a feed stock is charged to the furfural extraction unit, it must go straight through all three units and come out as a finished stock before it can be stored. This also means that all three units must always operate on the same stock at the same time. Excessive contamination from crossover stocks produced during stock changes is prevented by pumping out the surge tanks between units before stock swings, by running each stock a minimum of five days, and by scheduling plant operations to swing between adjacent stocks on stock changes.

In order to prevent possible contamination between products, each finished stock tank and each blended oil tank has its own individual pump and loading line. In this way it is impossible for any two products to become mixed while loading. A quick inspection on gravity or viscosity is sufficient to double-check that the correct tank was loaded.

The finished oil tankfield contains facilities for two different types of blending. On those few blended oils which move rapidly, batch blending is used. In this process the proper quantities of finished base stocks and additives are pumped from their individual storage tanks through preset displacement meters into a common blending tank. This blending tank is then heated and mixed by either air or mechanical mixing. After mixing, the blended oil is subjected to complete laboratory inspections for approval before it is pumped from the blending tank. After laboratory approval, the blend is pumped into one of 16 2000-bbl. blended oil storage tanks. By this method, Sohio is able to get complete laboratory approval before the oil leaves the blending tank; and, once pumped into a blended oil storage tank, the oil is ready for immediate loading. As many as 16 blended oils may be handled by this batch blending method.

On the other hand, many blended oils move in tankcar lots only at very infrequent intervals. For this type of movement, and because of the many oils of this type involved, Sohio cannot provide separate blended storage. This blending demand is handled by means of a continuous blender. When a truck or tankcar arrives for a slow-moving oil, the continuous blender is set to produce this blend, and the blend is run directly into the waiting truck or tankcar.

In order to prevent contamination of finished or blended oils from moisture condensation inside of the storage tanks, all product tanks are air conditioned with dry air. Two Pittsburgh Lectrodryer units are used to dry 1000 CFM of fresh air and blow it into all finished oil tanks in parallel. The drying units are self-regenerative and require little attention. The air is used only once, being blown into and across a tank, and out at the other side. The outlet vent is made smaller in size than the inlet nozzle in order to insure a slight positive pressure on each tank. In this way leakage of moist air into a finished product tank is completely prevented.

How to Estimate Plate Efficiency

Part 1—Rigorous Approach to the Plate Efficiency Correlation

Two methods are developed for estimating plate efficiency in distillation columns and gas absorbers. The first method, which is more rigorous, deals with the correlation of local Murphree plate efficiency. The second method correlates the overall plate efficiency of fractionating columns with L/V ratio, effective submergence, relative volatility of key components, and viscosity of the feed. A separate equation is presented for gas absorbers. Although more empirical, the equations developed by the second method represent convenient routes to compute the actual number of plates in distillation columns or gas absorbers.

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IN THE design of commercial distilling columns and gas absorbers, it is necessary to estimate the number of actual contacting plates equivalent to the calculated number of theoretical plates. Estimation of this conversion factor, plate efficiency, is a problem of considerable practical importance. Plate efficiency of distilling columns or gas absorbers has been expressed and reported in either one of the following three terms:

(1) Overall plate efficiency, E_o — the ratio of the number of theoretical plates to the number of actual plates required for the separation.

(2) Murphree plate efficiency, E_{MP} [22] — the degree of approach of the vapor or liquid to equilibrium with the liquid or vapor from an actual plate.

The Murphree plate efficiency can be expressed in terms of either concentration unit of lb.-moles per cubic foot of the fluid or mole fraction. Since the change of temperature and pressure across any two successive plates is small under normal operating conditions, it can be shown that Murphree plate efficiencies in vapor phase expressed in either units are almost numerically the same, giving:

$$E_{MP} = \frac{(C_{v_n})_{av} - (C_{v_{n+1}})_{av}}{(C_{v_n}{}^*)_o - (C_{v_{n+1}})_{av}} = \frac{(Y_n)_{av} - (Y_{n+1})_{av}}{(Y_n{}^*)_o - (Y_{n+1})_{av}} \quad \ldots\ldots (1)$$

Where C_v is the concentration in vapor phase in the unit of lb.-moles per cu. ft.; Y is the mole fraction of the same component in the vapor phase. Superscript "*" represents the vapor composition in equilibrium with the liquid; subscripts "n" and "$n+1$", represent the plate number counted from the top of the column. Subscript "av" refers to the average composition and "o" to the point where liquid overflows to the next plate.

Therefore $(C_{v_n})_{av}$ represents the average concentration of vapor leaving nth plate; $(C_{v_n}{}^*)_o$ refers to the vapor composition in equilibrium with liquid leaving nth plate; i.e., it is not the average liquid composition on the nth plate. Similarly, Murphree plate efficiency can also be experssed in terms of liquid composition.

(3) Local Murphree efficiency, E_{LM}.[20] The Murphree plate efficiency defined above employs either average vapor or liquid concentration and includes therefore the effect of concentration gradient across the plate. In terms of vapor composition, the local Murphree efficiency can be expressed as:

$$E_{LM} = \frac{C_{v_n} - C_{v_{n+1}}}{C_{v_n}{}^* - C_{v_{n+1}}} \quad \ldots\ldots (1a)$$

Where $C_{v_n}{}^*$ is the equilibrium vapor composition leaving a point of nth plate which would be in equilibrium with the liquid at that point; $C_{v_{n+1}}$ and C_{v_n} are the actual composition of vapor entering and leaving that point respectively.

In this paper two methods for evaluating plate efficiencies leading to the final calculation of the number of actual plates are developed and described. The first method, which is more rigorous, is developed according to similar basis employed by Geddes in his correlation.[10] The second method, although an approximate one, involves the estimation of overall plate efficiency from minimum amount of data by equations of simpler form and is more convenient to be applied. A great deal of experimental work on plate efficiencies in the literature reported few important variables of operation.[1,3,9,11,12,14,16,17,18,24,25,31,34] This makes the extensive test of both methods difficult, and correlations may seem to be tentative.

It is the author's hope that this paper may eventually stimulate more experimental research of better planning for future extensive correlation of complete satisfaction.

Local Murphree Plate Efficiency

Setting up the differential equation for the rate of mass transfer and integrating it across the plate at one point, Geddes derived[10] the following equation to relate the local Murphree plate efficiency with the over-all mass transfer coefficient of both liquid and vapor phases, K, time of contact between gas bubbles and liquid, t, surface area of contact, A, and the volume of gas bubbles, v:

$$\ln(1 - E_{LM}) = K\frac{At}{v} \quad \ldots\ldots (2)$$

This equation may be used for the vapor flow from a single slot, an entire cap, or a group of caps. As the interest is centered on the Murphree efficiency at a local point, and the performance of an average single bubble is assumed to represent the average performance of all bubbles formed at a single spot, Equation 2 will be further developed by evaluating the behavior of a single representative bubble.[10]

The recent study on bubble formation from the rectangular slots[19] indicated that bubbles from slots were almost never spherical. The bubbles first emerged nearly spherical at all gas rates and quickly developed flat or dished-in bottoms and wrinkle upper surface. The shapes were generally reproducible in all bubbles formed under the same conditions of orifice size and gas flow rate.[10] The effect of liquid properties has not been certain.

In the absence of definite quantitative information with regard to the shape of bubbles from the slots of a bubble cap, the bubble is assumed[9] to the sperical to carry on the development of Equation 2. For the spheres, V/A in Equation 2 is equal to one-sixth of diameter, $(\delta/6)$. Upon substitution into Equation 2, the latter reduces to the following from [10]:

$$\ln(1 - E_{LM}) = -\frac{6Kt}{\delta} \quad \ldots\ldots (3)$$

1. Overall Mass Transfer Coefficient

K in Equation 3 is the overall mass transfer coefficient accounting for both liquid and vapor phase resistances and is related to the individual liquid and vapor coefficients by [11,12,26]

$$\frac{1}{K} = \frac{1}{kg} + \frac{m}{k_L} \quad \ldots\ldots (4)$$

where kg and k_l are gas and liquid film coefficients of mass transfer, and m is the slope of the equilibrium curve. The units of symbols are all described at the end of the paper under "Nomenclature."

The slope of the equilibrium curve which is the vapor-concentration in equilibrium with the liquid divided by the liquid concentration, dC_v^*/dC_L, is different at different composition of the liquid. However, within relatively narrow range of liquid composition, some equilibrium curve may be almost a straight line and a constant value can be assumed for its slope. Since most vapor-liquid equilibrium data are expressed in terms of mole fraction, $Y-X$, it is desirable to express m in terms of mole fractions Y and X instead of the molar concentration, C.

Assigning an average value of 0.95 for the compressibility of vapors, the molar concentration of vapor in the unit of lb.-moles per cubic foot is related to its mole fraction through the following generalized equation of state:

$$C_v^* = \frac{PY^*}{0.693T} \quad \ldots\ldots (5a)$$

The molar concentration in the liquid is related to the mole fraction, molecular weight and density of liquid by:

$$C_L = \frac{\rho_L X}{M_L} \quad \ldots\ldots (5b)$$

Dividing Equation 5a by 5b, one obtains the expression for the slope of equilibrium curve:

$$m = \frac{dC_v^*}{dC_L} = \frac{PM_L}{0.693T\rho_L}\left(\frac{dY^*}{dX}\right) \quad \ldots\ldots (6)$$

For the binary systems of relatively constant relative volatility, α, their vapor-liquid equilibrium data is represented by,[6]

$$C_v^* = \frac{\alpha C_L}{1 + (\alpha - 1)C_L}$$

The slope of equilibrium curve can be calculated from liquid composition only by:

$$m = \frac{dC_v^*}{dC_L} = \frac{\alpha}{[1 + (\alpha - 1)C_L]^2}$$

$$= \frac{\alpha}{\left[1 + (\alpha - 1)\dfrac{\rho_L X}{M_L}\right]^2} \quad \ldots\ldots (6a)$$

Through the analogy between heat and mass transfer, [2,4,5,19,26,27] the mass transfer coefficient in the gas phase can be similarly correlated as heat transfer coefficient.

Among the analogies mentioned in the literature, the most convenient form which agrees quite closely with most experimental values of mass transfer is one proposed by Chilton-Colburn:[4,5]

$$kg = \frac{0.023 v_a}{(N_{Re})^{0.2}(N_{Sc})^{2/3}} \quad \ldots\ldots (7)$$

where:

v_a = vapor velocity
N_{Re} = Reynolds number, dimensionless
N_{Sc} = Schmidt number, dimensionless

Chilton-Colburn's analogy refers to a turbulent flow in a round pipe. There seems to be some technical difficulty in applying Equation 5 to the mass transfer between bubbles rising from the slots of bubble caps and the surrounding liquid. The flow of vapor through the slots and liquid on the plate, at first thought, seems to be no way in resemblance with the flow through a round pipe. In evaluating Reynold's number in Equation 5, it is difficult to determine the values to be used for the diameter of the tube through which the flow of vapor takes place, and the linear velocity for the flow of the vapor.

Visual observation[30] of formation and rising of gas bubbles in liquids from a single immersed orifice indicated the existence of two types of bubbling. At low rate of flow of gas, separate bubbles are formed from the slots and rise through the liquid in a vertical direction. As the flow rate increases and passes a critical value,[30] the frequency of the bubble formation will be increased to such extent that the bubbles rise through the liquid one after another in series, like a continuous chain. The vertical slots in a bubble cap might give a picture different from that of a single horizontal orifice, and the presence of a number of slots in a bubble cap and the proximity of the slots of other caps on an actual plate may create the collision between different bubbles, changing their size and, consequently, their ascending velocity with possible deviation of their direction of flow from the original vertical line. However, to facilitate the estimation of mass transfer coefficient inside gas bubbles on the plate, bubbles formed from one slot are considered as chain-like bubbles arising in a vertical position without change of its size during their travel to the top level of the liquid. In the operating range of vapor rate this assumption of chain-bubbling, which is valid in commercial columns, will lead to a picture that each bubbling chain resembles a flow of gas through a round tube of diameter equal to that of the spherical bubbles, δ, and make the application of Chilton-Coburn's analogy possible if v_a represents the ascending velocity of bubbles through the liquid. A complete expression for the mass transfer coefficient in the vapor phase can be obtained by substituting terms of physical properties into two dimensionless groups in Equation 5, giving:

$$kg = \frac{0.023 v_a}{\left(\dfrac{\mu_v}{\rho_v D_v}\right)^{2/3}\left(\dfrac{\delta\, v_a\, \rho_v}{\mu_v}\right)^{0.2}} \quad \ldots\ldots (8)$$

where:

δ = diameter of bubbles, ft., calculated by Equations 21 and 23, or 21a and 23a, the derivation of which will be discussed later.
ρ_v = density of the mixed vapor rising through the bubble caps in distilling columns, lbs./cu. ft.
μ_v = viscosity of the mixed vapor, lbs./hr. ft.
D_v = gaseous diffusivity, sq. ft./hr.

Although the gaseous diffusivity, D_v, and viscosity, μ_v, and density, ρ_v, of the vapor vary with temperature and pressure, the combination of these three properties

TABLE 1—Atomic Volumes[26]

Oxygen in:	
Aldehydes and ketones	7.4
Methyl ester	9.1
Methyl ethers	9.9
Higher esters and ethers	11.0
Acids	12.0
Bromine	27.0
Carbon	14.8
Nitrogen:	
Double-bonded	15.6
Primary amines	10.5
Secondary amines	12.0
Chlorine	24.6
Hydrogen	3.7
Iodine	37.0
Sulfur	25.6

in Schmidt number, $\mu_v/\rho_v D_v$, makes the latter independent of pressure and insensitive to the change of temperature as indicated by both theory and experiments.[26]

In calculating the Schmidt number, the gaseous diffusivity, if not available in the literature, can be estimated by the following equations:

BINARY SYSTEM:

Gilliland has proposed the empirical equation:[5,26]

$$D_v = 0.00684 \frac{T^{3/2}}{P(v_A^{1/3} + v_B^{1/3})^2} \sqrt{\frac{1}{M_A} + \frac{1}{M_B}} \quad \ldots\ldots (9)$$

where:

D_v = diffusivity of gas, sq. ft/hr.
T = temperature, °R
P = total pressure, atm.
M = molecular weight
v_m = molecular volume computed from atomic volumes listed in Table 1.
A, B = represent compounds A and B.

Diffusivity may be estimated from the intermolecular potential energy by the general theory developed by Chapman and Cowling.[15] By employing a specific form for the intermolecular potential energy, Hirschfelder et al[15] developed a satisfactory correlation for diffusivities of simpler compounds:

$$D_v = \frac{8.57 \times 10^{-3} T^{3/2} \sqrt{\frac{1}{M_A} + \frac{1}{M_B}}}{P(v_{cA}^{1/3} + v_{cB}^{1/3})^2 f(T/0.75\sqrt{T_{cA}T_{cB}})} \quad \ldots\ldots (10)$$

where:

Tc = critical temperature
v_c = critical volume, cc. per g-mole; if experimental data are not available, it can be estimated from parachor, p' by Meissner's equation:

$$v_c = (0.377\ p' + 11.0)^{1.25} \quad \ldots\ldots (11)$$

$f(T/0.75\sqrt{T_{cA}T_{cB}})$ is a function of $T/0.75\sqrt{T_{cA}T_{cB}}$ and can be read from a figure given by Hirschfelder et al.[15]

MULTIPLE COMPONENT SYSTEM:

From the Stefan-Maxwell diffusion equations, Wilke[33] developed the following expression for the diffusivity of compound A with respect to a multi-component mixture containing compounds A, B, C . . . .etc.:

$$D_{vA} = \frac{1 - Y_A}{\frac{Y_B}{D_{vAB}} + \frac{Y_C}{D_{vAC}} + \frac{Y_D}{D_{vAD}} + \cdots\cdots} \quad \ldots\ldots (12)$$

Application of this relation which relates the diffusivity in a multicomponent mixture to those of different binary systems was studied by comparison with exact solutions of the diffusion equations for various types of diffusion and was supported by experimental evidence.[33]

For the mass transfer in the liquid phase, k_L, one can imagine a picture of mass transfer between a cylinder created by chain-bubbling and its surrounding liquid. The recent work of Linton and Sherwood[21] explored the Chilton-Colburn's analogy to mass transfer in turbulent flow of liquids representing a 1000-fold extension of the experimental range of the Schmidt group. Their experimental data were obtained on the rate of solution of cast tubes, cylinders, plates and spheres of benzoic acid, cinnamic acid and 2-naphthol in water in both streamline and turbulent flow. Under the same assumption of turbulent flow as in the gaseous diffusion, the mass transfer coefficient in the liquid phase, k_L, can thus be calculated by a similar equation:[19]

$$k_L = \frac{0.623\ v_a}{\left(\frac{\mu_L}{\rho_L D_L}\right)^{2/3} \left(\frac{\delta\ \rho_L v_a}{\mu_L}\right)^{0.2}} \quad \ldots\ldots (13)$$

The nomenclatures in Equation 13 are the same as those in Equation 7, with the exception that the subscript $_L$ is used to indicate the values for the liquid phase.

The experimental value of the liquid diffusivity is used in evaluating the Schmidt number wherever it is available in the literature.[24] Owing to the difficulty of eliminating natural convection and the occurrence of association and dissociation in the liquid state, the present method for determining the liquid diffusivity has not been satisfactory.[5] Wilke [32] developed a method for the estimation of diffusion coefficients based upon the relationships suggested by the theory of absolute reaction rates and Stokes-Einstein equation. Correlation has been made through the equation:

$$D_L = \frac{3.884T}{F\mu} \quad \ldots\ldots (14)$$

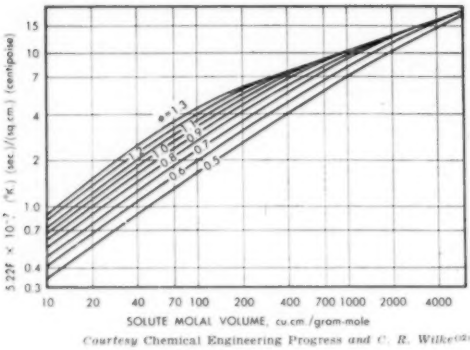
where F is the Diffusion Factor, (°R)(hr.)²/(lb.)(ft.)

Within the limits of available data, F is independent of the temperature for a given liquid system. For the diffusion of various solutes in a given solvent, F is a function of the molal volume of the solute. Curves of F versus the molal volume of the solute have been developed for the diffusion through water, methanol and water.[32] The experimental observed data gave an average deviation of 10% from Equation 14. Diffusion factor in any other solvent may be estimated if it is assumed that the data will correlate on a curve having a constant solvent factor, ϕ in Fig. 1. A minimum of one experimental value is necessary to characterize the solvent. When experimental data are not available, the use of a solvent factor, $\phi = 0.9$, is recommended.[32] The method, however, is considered reasonably satisfactory for the estimation of diffusion coefficients in dilute solution.

2. Time of Contact

Time of contact of a given bubble represented by t, in Equation 3, is equal to the distance of travel through the fluid divided by the ascending velocity of the bubble through the fluid. In a commercial fractionating tower the ascending velocity of the mass of bubbles is apparently greater than that for an isolated bubble in a large amount of liquid. According to Geddes,[10] the effective time of contact for a gas bubble taken as the mean slot submergence with respect to the weir crest divided by the ascending velocity for an isolated bubble is equal to the actual time of contact of a bubble in the mass of bubbles through large amount of liquid. This assumption approaches to actual mechanism in a tower operating at higher pressure. Geddes arrived at this conclusion through the reasoning illustrated in the following paragraph.

In the flow of a dispersed mass of gas through a moderate depth of liquid confined in a long vertical tube, the bubbles formed are few and widely separated and the ascending velocity is equal to that of an isolated bubble.



Courtesy Chemical Engineering Progress and C. R. Wilke[12]

FIG. 1—Diffusion factor

In this case the top surface of the liquid rises slightly with expansion equivalent to the volume of the gas bubbles in passing through the liquid at that moment. As the vapor rate increases, the surface of liquid rises with an increase of traveling distance for the bubbles. In the extreme case of very high vapor rate, the picture resembles thin undulating vertical sheets of liquid suspended in a mass of rising bubbles. The froth becomes higher and the suspended fibre becomes thinner as the vapor rate increases.

Similar picture has been observed[10] on a bubble plate. The increased bubble rate is compensated by the increased height of the liquid level for the bubbles to travel. This is equivalent in saying that the actual time of contact of vapor bubbles with the liquid on a double plate in operation is just equal to time of contact of an isolated bubble with a quiescent liquid, giving:[10]

$$t = \frac{h_w + h_L + 1/2h_s}{v_a} \qquad (15)$$

h_w is the head of liquid over weir; h_L distance from the top of slot to the weir lip; h_s slot height. The summation of these three terms, all in the unit of feet, represents the average depth of liquid in quiescent state through which a bubble travels.

3. Bubble Size and Its Ascending Velocity

Although superficial observations give the size of the bubble as about ¼-in. diameter for an ordinary round cap with narrow slots, little data on sizes of bubbles from plates in operation have been published in the literature.[8,10] Davidson and Amick[8] bubbled air through orifice and rectangular slots immersed in water and *p*-cymene at slow rate and reported that slot width and flow rate have little effect on bubble size. Geddes[10] adapted the theoretical equation for the size of a bubble developed slowly and under equilibrium condition from a vertical slot and modified the value of constant from 0.78 to unity in the equation empirically to account for the condition of rapid flow on an actual plate, giving:

$$\delta = \left[\frac{\sigma(h_s + w)}{\rho_L - \rho_v}\right]^{1/3} \qquad (16)$$

where:

σ = surface tension of the liquid, lb./ft.

w = slot width, ft.

Davidson and Amick[8] found that this equation gave a bubble radius only about one-third of the size formed in their work under the same flow condition. At the rates of flow prevailing in normal operation on bubble plates, the effective bubble size is, indeed, smaller than it would be at low flow rates. The decrease in size is created by the turbulence and agitation in the liquid. Recent work on plate efficiency in extractive distillation gave poor quantitative agreement with Geddes correlation.[11,14] As the basis of Geddes correlation, in principle, was generally sound, the discrepancy was explained[14] by a pronounced calming effect in the plate action with respect to splashing and entrainment for given vapor velocities. The use of a new value for the empirical constant in Equation 16 might result in satisfactory agreement with the experimental values. This constant, as guessed by Grohse et all,[14] may be a function of the liquid rate which was not included in the Geddes method.

The recent contribution on the study of formation and rising of gas bubbles in liquid[30] is used here to evaluate the radius of the bubbles as well as their ascending velocity through liquid on a bubble plate. Chain-bubbling of gas through the liquid, which is the actual phenomena on a plate in a fractionating column or gas absorber, takes place in two regions, turbulent and streamline, on the basis of experimental results. Experimental results were graphically correlated by plotting the expansion group, which is a dimensionless group represented by

$$\frac{g\delta(\rho_L - \rho_v)}{v_a^2 \rho_L}$$

versus the Reynold's number. In the streamline region, the expansion group is inversely proportional to Reynold's number, giving

$$N_{EX} = \frac{18}{N_{Re}} \qquad (17)$$

which, upon the substitution of the dimensionless groups, gives the bubble diameter:

$$\delta = \left[\frac{18\mu v_a}{g(\rho_L - \rho_v)}\right]^{1/2} \qquad (18)$$

where g is the gravitational constant, 4.18×10^8 ft./hr.^{2}.

For the spherical bubble, the ascending velocity through liquids, v_a, is related to the volumetric flow rate of vapor, Q_v, by:

$$Q_v = \left(\frac{\pi}{6}\delta^3\right)\left(\frac{v_a}{\delta}\right) = \frac{\pi\delta^2 v_a}{6} \qquad (19)$$

Molal flow rate of vapor is used more frequently in the distillation calculation. The volumetric flow rate is converted to the molal flow rate of vapor by the following generalized equation of state if an average value of 0.95 is assigned to the compressibility factor of vapors:

$$Q_v = 0.693\,\frac{TV}{P} \qquad (20)$$

Substituting Equations 19 and 20 into Equation 18, one obtains the final expression for the bubble diameter in the streamline region:

$$\delta = 0.01545\left[\frac{VT\mu_L}{P(\rho_L - \rho_v)}\right]^{1/4} \qquad (21)$$

This equation indicates that the bubble diameter is a function of liquid viscosity, vapor rate, and the difference between liquid and vapor density. Although the equation is derived from the experimental results of an orifice, the diameter or the dimension of the orifice gives no effect on the bubble size. For this reason, the same equation is recommended for the calculation of size of bubbles from slots of a bubble cap in the absence of additional information concerning the latter.

In the turbulent region, the expansion group is a constant and independent of Reynold's number, giving:

$$\delta = \frac{2\,v_a^2\,\rho_L}{g(\rho_L - \rho_v)} \qquad (22)$$

which, upon substitution of Equation 19, gives the bubble diameter in the turbulent region:

$$\delta = 0.02418\left[\frac{V^2T^2\rho_L}{P^2(\rho_L - \rho_v)}\right]^{1/5} \qquad (23)$$

This equation, which is derived from experimental results of orifices, indicates the independence of the bubble diameter from the dimension of an orifice, and is recommended for the calculation of the diameter of bubbles from slots of a bubble cap.

To determine which is the right equation between (21) and (23) to use, the critical value of flow rate of the vapor dividing the turbulent or streamline region of flow should be calculated first. At the critical value the bubble diameter in chain-bubbling from a circular orifice[30] was found equal to the theoretical value for a separate bubble formation,[7,9,29] given by the following equation:

$$\delta = \left[\frac{6\,\sigma\,d}{(\rho_L - \rho_v)}\right]^{1/3} \qquad (24)$$

where d is the orifice diameter, ft. Equating Equations 24 to 23, one obtains the critical value of flow rate of the vapor through an orifice as:

$$Q_v = \left[\frac{20\sigma^5 d^5\, g^3}{\rho_L^3(\rho_L - \rho_v)^2}\right]^{1/6} \qquad (25)$$

Equation 24 is derived by considering that the buoyancy of the bubble just balances the surface force holding the bubbles to the orifice at the moment when a bubble is just on the verge of breaking away from an orifice. For the rectangular slots, the length along which the surface tension is acting, equals twice the slot height plus width, $h_s + w$. For this reason the diameter term of orifice, d, in Equation 25 should be replaced by $2(h_s + w)/\pi$ to give the critical value of flow rate from a rectangular slot. The resulting equation is further transformed with the substitution of Equation 20, giving the critical flow rate:

$$V = 3.33 \times 10^4 \frac{P}{T}\left[\frac{\sigma^5(h_s + w)^5}{\rho_L^3(\rho_L - \rho_v)^2}\right]^{1/6} \qquad (26)$$

It is interesting to note that the surface tension and the dimension of slots appear only in the expression of critical flow rate of vapor. They are important in locating the region of the flow, streamline or turbulent, but have no effect in determining the bubble size in either streamline or turbulent region.

In deriving Equations 21 and 23, the circulation of liquid except by the action of the bubbles is assumed to be absent. In an actual column, especially in extractive distillation where a large amount of liquid solvent flows from plate to plate, it is believed that a factor which may be a function of liquid rate, or possibly a ratio of liquid to vapor rate, should be used as a multiplying factor in Equations 21 and 23, giving the bubble diameter:

Streamline region:

$$\delta = 0.01545\, f(L/V)\left[\frac{VT\mu_L}{P(\rho_L - \rho_v)}\right]^{1/4} \qquad (21a)$$

Turbulent region:

$$\delta = 0.02418\, f(L/V)\left[\frac{V^2T^2\rho_L}{P^2(\rho_L - \rho_v)}\right]^{1/5} \qquad (23a)$$

where L is the flow rate of liquids in the column expressed in lbs.-mols/hr. For the lack of experimental data, $f(L/V)$ is unknown at present. It is the hope of the author to see the progress of research along this direction which might result in satisfactory correlation of all experimental data in plate efficiency and a wide application of the proposed method which follows a similar approach of Geddes' method.[10]

The ascending velocity for bubbles formed in series has been found independent of the dimension of orifice[30] and the same equation is therefore recommended for its calculation, giving:

$$v_a = \frac{(g\,\delta)^{1/2}}{2} \qquad (27)$$

the value of δ can be calculated from either Equation 21a or 23a, depending on whether the flow is streamline or turbulent.

Relation Between 2 Murphree Plate Efficiencies and Overall Plate Efficiency

While it is unreasonable to have *local* Murphree plate efficiency greater than 100%, it has long been recognized that the presence of a liquid concentration gradient across a plate may yield the value of *plate* Murphree efficiency greater than 100% on the basis of the average vapor composition and the composition of the liquid leaving the plate. Lewis[20,23] gave mathematical analyses of three cases for binary systems with respect to the condition of mixing of vapor and liquid streams from the plate, and numerical comparison between plate and local Murphree plate efficiencies. Three cases considered by Lewis[20] are:

1. Liquid flow is in opposite direction on successive plates and unmixed on the plate; vapors leaving the plate are completely mixed:

$$E_{MP} = \frac{C^{E_{LM}mV/L} - 1}{mV/L} \qquad (28)$$

2. Liquid flows in the same direction without mixing on plates; vapor flows unmixed:

$$E_{MP} = \frac{Y_{nr} - 1}{\left(\frac{1}{E_{LM}} + \frac{1}{Y_{nr} - 1}\right) L_n(Y_{nr} - 1)} \qquad (29)$$

where $Y_{nr} = \dfrac{Y_n - (Y_n)_o}{Y_{n+1} - (Y_{n+1})_o}$ (30)

$(Y_n)_o$ is the mole fraction of the more volatile component in vapor leaving nth plate at a point where the liquid overflows to the next plate.

3. Liquid flows in opposite direction on successive plates without mixing; vapor flow is also unmixed.

$$E_{MP} = \frac{Y_{nr} - 1}{f(E_{LM}, Y_{nr}) - 1} \qquad (31)$$

$$f(E_{LM}, Y_{nr}) = \sqrt{\frac{Y_{nr}^2(1 - E_{LM})^2}{E_{LM}^2(1 - Y_{nr})^2}}\cos h^{-1} \times \left[1 \pm \frac{(1 - Y_{nr})(Y_{nr} - 1 + E_{LM})}{Y_{nr}(2 - E_{LM})}\right] \qquad (32)$$

For $Y_{nr} > 1$, the sign in the parenthesis is positive; for $Y_{nr} < 1$, the sign is negative.

The analytical solutions of these equations are tedious and difficult. For this reason, Lewis[20] gave the numerical solution in Table 2.

In distilling columns operating at constant molal overflow from plate to plate in each section, the ratio V/L is equal to $(R + 1)/R$ in the enriching section; to $S/(S + 1)$ in the stripping section. R is the reflux ratio

TABLE 2—Numerical Solution of Lewis' Equations (28, 29, 31, 32) for Murphree Plate Efficiency[20]

	E_{LM}	E_{MP}				
mV/L	0	0.5	1.0	1.5	2.0
Case 1	0.20	0.20	0.21	0.22	0.23	0.25
	0.40	0.40	0.44	0.49	0.55	0.61
	0.60	0.60	0.70	0.82	0.97	1.16
	0.80	0.80	0.98	1.23	1.55	1.98
	1.00	1.00	1.30	1.72	2.32	3.19
Case 2	0.20	0.20	0.21	0.22	0.23	0.25
	0.40	0.40	0.45	0.50	0.56	0.63
	0.60	0.60	0.72	0.86	1.03	1.25
	0.80	0.80	1.03	1.33	1.73	2.26
	1.00	1.00	1.43	2.00	2.79	3.92
Case 3	0.20	0.20	0.21	0.22	0.23	0.25
	0.40	0.40	0.44	0.49	0.54	0.60
	0.60	0.60	0.70	0.81	0.94	1.10
	0.80	0.80	0.97	1.16	1.41	1.73
	1.00	1.00	1.21	1.50	1.90	2.47

and is defined as the molal ratio of reflux liquid going back to the column to the product taken off overhead, S is the reboil ratio or boil-up ratio, defined as the molal ratio of vapor rising from the reboiler to the liquid taken off as bottom product. As indicated in these equations, the difference between two Murphree efficiencies becomes greater as the reflux ratio approaches the minimum value, and the reboiler ratio reaches the maximum value required for a given separation.

Graphical solutions of Equations 28, 29, 31 and 32 have been presented by Colburn and Pigford[26] and reproduced in Figs. 2, 3 and 4 in this paper to facilitate the conversion of local Murphree plate. In these figures, the Murphree plate efficiency is plotted versus local Murphree plate efficiency using parameter "J" representing the term $m(R + 1)/R$.

As pointed out by Carey,[26] the majority of commercial towers fall between Cases 1 and 3 in the actual mechanism of flow. The bottom plate which receives the well mixed vapor from the reboiler, belongs to Case 1. For plates well up in the upper part of the column, the vapor flow becomes unmixed and is close to Case 3. It might be pointed out here that Figs. 2 and 4, as well as Lewis' relations[20] which are represented by Equations 28 and 32, are limited to the binary systems with liquid flow unmixed on each plate; no split flow is involved. Although the local disturbance may cause some local circulation of liquid, the assumption of non-mixing of liquid in its direction of flow is not far from the actual realization in a commercial tower.

Conversion of Murphree Plate Efficiency to Overall Plate Efficiency

The Murphree plate efficiency is the same as overall plate efficiency under either one of the following conditions:

1. If the average composition of the vapor from the plate is in equilibrium with that of the liquid from the same plate. This means that the plate efficiency is 100%.

2. If the ratio of vapor rate to liquid rate is always equal to the slope of equilibrium curve; i.e.:

In enriching section: $R/(R + 1) = m$ ..... (33)

In stripping section: $S/(S + 1) = m$ ..... (34)

For a system operated in a column under universal assumptions imposed by McCabe-Thiele's method, the operating line is a straight line with its slope, $R/(R + 1)$, equal to a constant value. Lewis' relations may be extended to the multicomponent mixture if the procedure suggested by Hengstebeck is followed.[7] Multicomponent systems are treated as binary systems of the key components with liquid and vapor quantities in the distilling column adjusted to "effective" quantities, which are calculated upon the following assumptions:

1. Negligible concentrations in the stripping section of components more volatile than the key components.

2. Negligible concentration in the rectifying section of components less volatile than the key components.

3. Values for the "constant concentrations" of the components lighter and heavier than the keys. The "effective" liquid and vapor quantities, i.e., quantities of the keys present in the liquid and in the vapor, are approximated by subtracting the "constant" quantities calculated from the total liquid and vapor quantities. Composition of feed, overhead and bottom products, in terms of mole fraction of the light key, are also converted into "effective mole fraction" of the light key. These values of "effective quantities" are used then to determine the required number of theoretical plates by a McCabe-Thiele construction in which the keys are treated as a binary system.

The necessary condition to satisfy condition 2 is to have the equilibrium curve as a straight line parallel to the operating line in the range of composition prevailing in the column from the bottom of the plate to top. Of course, this may be possible only when the concentration range is rather narrow.

In most cases where either one of the above conditions doesn't exist, the overall plate efficiency and Murphree plate efficiency are not equal. Their relationship derived by Lewis[20] is as follows:

$$E_o = \frac{\log\left(1 + E_{MP}\left(\frac{mV}{L} - 1\right)\right)}{\log\left(1 + E_{LM}\left(\frac{mV}{L} - 1\right)\right)} \quad \text{..... (35)}$$

This equation is strictly applied to the binary system with constant slope of equilibrium curve operated under constant molal overflow. The equation can be applied to the enriching and stripping section separately to evaluate the overall plate efficiency for each section. If the slope of the equilibrium curve changes across each section, the arithmetic mean between the top and the

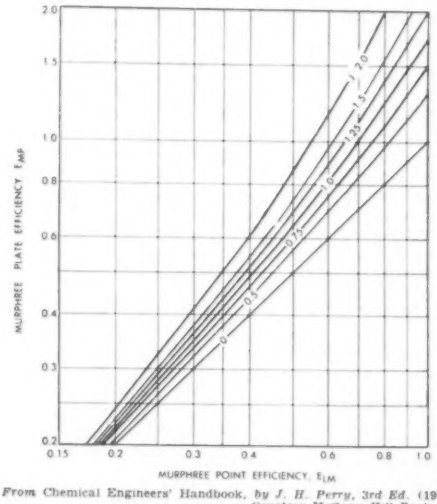


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FIG. 2—Relation of point efficiency to over-all Murphree point efficiency

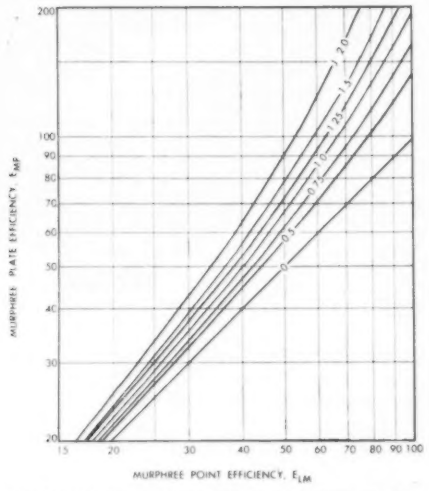

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FIG. 3—Relation of Murphree efficiency to point efficiency for no blending of liquid on plates and no blending of vapor between plates. Parallel flow of liquid on successive plates

bottom of the section can be used as an approximation to evaluate the overall plate efficiency by Equation 35, provided the change is not too large. Hengstebeck's method may also be employed here to extend the procedures to multicomponent systems.(7)

As a matter of fact, the Murphree plate efficiency can be directly used in the plate to plate calculation to find the actual number of plates without going through the overall plate efficiency. This would be the only procedure to find out the number of actual plates if the slope of the equilibrium is not constant and changes appreciably across each section of distilling columns. For binary system, the McCabe-Thiele's stepwise procedure on an $X - Y$ diagram can be used with slight modification. The graphical procedure starts from the point on the diagonal where the abscissa X equals X_w, the composition of the bottom product, by drawing a vertical line to the equilibrium curve. Locate a point on this vertical line at a height equal to $E_{MP}\%$ of the total height between the equilibrium curve and the starting point. Next draw a horizontal line from this point, as the ordinary McCabe-Thiele's procedure, to the operating line. Continue to draw rectangular steps between the operating line and the points which are $E_{MP}\%$ approach to the equilibrium curve until the top of the column is reached. With this modified procedure, the actual number of plates can be found even if the Murphree plate efficiency varies considerably from tray to tray in the column. A similar procedure can also be used when the molal overflow is not a constant and Ponchon's method is employed.

Summary of Working Equations

The final working equations used for evaluating local Murphree plate efficiency and the procedures for calculating the actual number of plates from the latter are summarized here. For the explanation of symbols and units, refer to either the previous text or the list of Nomenclature at the end of the paper.

Local Murphree plate efficiency, E_{LM}:

$$\ln(1 - E_{LM}) = -\frac{6Kt}{\delta} \qquad (3)$$

Time of contact, t:

$$t = \frac{h_w + h_L + 1/2h_s}{v_a} \qquad (15)$$

Ascending velocity or velocity of rise of bubbles, v_a:

$$v_a = \frac{(g\,\delta)^{1/2}}{2} \qquad (27)$$

Overall mass transfer coefficient, K:

$$\frac{1}{K} = \frac{1}{kg} + \frac{m}{k_L} \qquad (4)$$

Slope of equilibrium curve, m:

$$m\,\frac{dC_v^*}{dC_L} = \frac{PM_L}{0.693T\rho_L}\left(\frac{dY^*}{dX}\right) \qquad (6)$$

For binary systems with relatively constant relative volatility,

$$m = \frac{\alpha}{\left[1 + (\alpha - 1)\dfrac{\rho_L X}{M_L}\right]^2} \qquad (6a)$$

Mass transfer coefficient in gas phase, kg:

$$kg = \frac{0.023 v_a^{0.8}}{\left(\dfrac{\mu_v}{\rho_v}\right)^{0.467} \dfrac{\delta^{0.2}}{D_v^{2/3}}} \qquad (8a)$$

Mass transfer coefficient in liquid phase, k_L:

$$k_L = \frac{0.023 v_a^{0.8}}{\left(\dfrac{\mu_L}{\rho_L}\right)^{0.467} \dfrac{\delta^{0.2}}{D_L^{2/3}}} \qquad (13a)$$

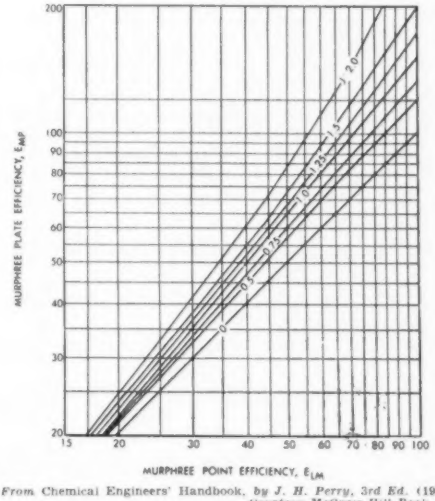

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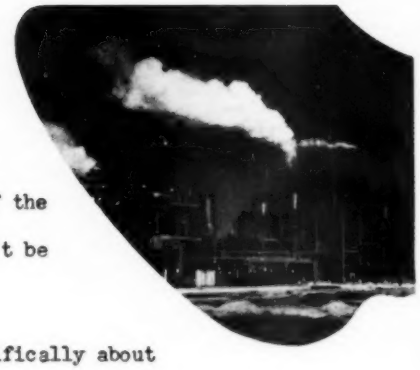
FIG. 4—Relation of Murphree efficiency to point efficiency for no blending of liquid on plates and no blending of vapor between plates. Opposite flow of liquid on successive plates



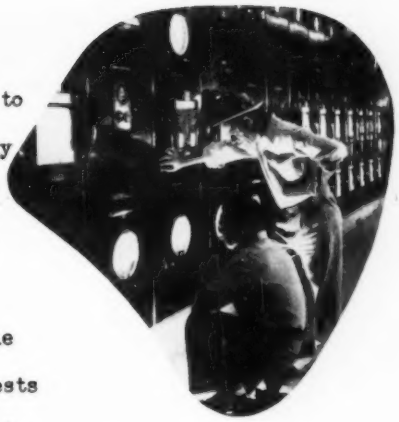
Dear Bill:

Thanks for your frank criticism. We try to say in our advertising a lot of the things you suggest. But some just can't be detailed.

For instance, we can't talk specifically about the cost of projects. I certainly do agree that the work our purchasing people have recently done has been outstanding - they really scurried around and are buying equipment and material at prices far under what we had any reason to suspect. However, although we often finish a job well under the estimate, obviously no client wants us to divulge specific cost information about his particular plant.

In our ads we sometimes speak of speed of completion and many of our projects are finished ahead of schedule with financial advantage to our clients in putting products on the market sooner. But, as you know, many factors affect a schedule and just plain speed doesn't always result in economy. There's no sense in sending a man out in the field to pour foundations if the stuff going on those foundations won't arrive for a couple of months. What we try to talk about is Badger's careful planning and coordination that produce savings in time and money.

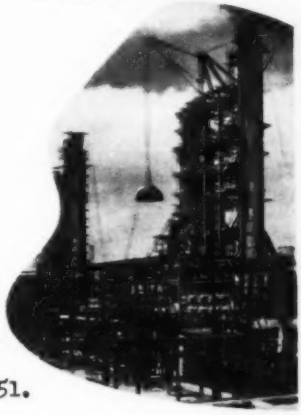
Again, many times we develop new ideas in cooperation with a



client's engineering staff, or adapt old ideas to new problems. The results are often immensely valuable to the client; yet to protect the client's interest we can't spell out our part in his success. Badger's fine reputation of ethical dealing is invaluable insurance to a client that his financial interests and industrial secrets will be protected, and is one of our most precious assets.

You ask why we don't emphasize more of our outstanding success stories, like those crude units which operated continuously for 796 days and processed 15,000,000 barrels without interruption. Well, we'd rather talk about our consistently good record than get into a bragging contest with our competitors.

Fundamentally we want to show how our broad experience in many varied fields is combined in one skilled, effective, integrated organization - and to emphasize Badger's basic know-how in the process industries.



Thanks for your letter though, Bill, and thanks for your other ideas which we will use during 1951.

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With the substitution of Equations 4, 6, 8a, 13a, 15 and 27 into Equation 3 and simplification of the resulting equation, the *final expression* for *local Murphree plate efficiency* is obtained, giving:

$$\log \frac{1}{1-E_{LM}} = \frac{8.77 \times 10^{-3}}{\delta^{0.467}} \times \frac{(h_w + h_L + \frac{1}{2}h_s)}{\frac{1}{D_v^{2/3}}\left(\frac{\mu_v}{\rho_v}\right)^{0.467} + \frac{PM_L}{0.693 T \rho_L D_L}\left(\frac{dY^*}{dX}\right)\left(\frac{\mu_L}{\rho_L}\right)^{0.467}} \quad (36)$$

To calculate the bubble diameter, δ, in Equation 36, the critical value of molal flow rate of vapor, V, dividing the streamline and turbulent flow regions should first be computed from:

$$V = 3.33 \times 10^4 \frac{P}{T}\left[\frac{\sigma^5 (h_s + w)^5}{\rho_L^3 (\rho_L - \rho_v)^2}\right]^{1/6} \quad (26)$$

Streamline flow:

$$\delta = 0.01545\left[\frac{VT\mu_L}{P(\rho_L - \rho_v)}\right]^{1/4} \quad (21)$$

Turbulent Flow:

$$\delta = 0.02418\left[\frac{V^2 T^2 \rho_L}{P^2 (\rho_L - \rho_v)}\right]^{1/5} \quad (23)$$

For extremely high flow rate of liquid as in extractive distillation, the actual bubble diameter might be greater than those calculated by Equations 21 and 23. In the absence of definite experimental information, the correcting factor is guessed to be a function of the molal ratio of liquid to vapor rate of flow, $f(L/V)$.

Local Murphree plate efficiency can be converted into Murphree plate efficiency by Equations 28-32, the choice of which depends upon the condition of mixing of vapor and liquid streams from the plate. Among the cases considered by Lewis,[19] only Cases 1 and 3 represent conditions prevailing in the majority of commercial towers.

The plate to plate calculation for theoretical plates can be slightly modified to evaluate the actual number of plates if Murphree plate efficiency for each plate is known. This modification is also possible in the graphical solutions, such as McCabe-Thiele's and Ponchon's methods. An approximate and more rapid computation of actual number of plates is to use Murphree plate efficiency for a plate representing average conditions of all plates in one column or in each section of the column. Calculate overall plate efficiency from Murphree plate efficiency by Equation 35. The number of theoretical plates divided by overall plate efficiency gives the actual number of plates.

Acknowledgement

The preceding part of this paper represents a preliminary work of the "Plate Efficiency" research project conducted at Polytechnic Institute of Brooklyn and financed by Research Corp. of New York, to which grateful acknowledgement is made.

Part 2, to be published in a future issue, will present a "Short Method" for estimating overall plate efficiency,

Nomenclature

A = surface area, sq. ft.
$B = E_o/(L/V)^{0.365}(\mu_L)^{0.365}$feed$^{-0.365}$
B_o = value of B at effective submergence of 0.75 inches.
C = concentration, lb.-moles/cu.ft.
d = diameter of orifice, ft.
D = diffusivity, sq.ft./hr.
E_o = overall plate efficiency.
E_{MP} = Murphree plate efficiency.
E_{LM} = local Murphree plate efficiency.
F = diffusion factor, (°R.)(hr.)²/(lb.)(ft.)
g = gravitational constant, 4.18×10^8 ft./hr.²
h_e = effective submergence, $h_L + 1/2\ h_s$
h_L = distance from the top of slot to the weir lip, ft.
h_s = slot height, ft.
h_w = head of liquid over weir, ft.
H = Henry's law constant, lb.moles/(cu.ft.)(atm.)
k_g = gas transfer coefficient, lb.moles/(sq.ft.)(hr.)(lb.mole/cu.ft.)
k_L = liquid transfer coefficient, lb.moles/(sq.ft.)(hr.)(lb.mole/cu.ft.)
K = overall mass transfer coefficient, lb.moles/(hr.)(sq.ft.)(lb.moles/cu.ft.)
L = flow rate of liquid, lb.moles/hr.
m = slope of equilibrium curve.
M = molecular weight, lbs./lb.mole.
N_{Re} = Reynolds number, dimensionless.
N_{Sc} = Schmidt number, dimensionless.
P = pressure, atm.
p' = Parachor.
Q_v = volumetric flow rate of vapor, cu.ft./hr.
R = reflux ratio, $L/(V\text{-}L)$, above feed plate.
S = reboil ratio, $V/(L\text{-}V)$, below feed plate.
T = temperature, °R.
v = volume, cu.ft.
v_t = ascending velocity of bubbles, ft./hr.
V = flow rate of vapor, lb.-moles/hr.
w = slot width, ft.
X = mole fraction in liquid phase.
Y = mole fraction in vapor phase.
$Y_{av} = [Y_n - (Y_n)_e]/[Y_{n+1} - (Y_{n+1})_e]$
Z = compressibility factor, dimensionless.
δ = equivalent diameter of bubble, ft.
ρ = density, lbs./cu.ft.
μ = viscosity, lbs./hr.ft.
Φ = solvent factor, dimensionless.
σ = surface tension of liquid, lbs./ft.
α = relative volatility, dimensionless.
τ = log E_o + 0.246 log (μ_L feed)

Subscripts

av = average value.
A,B,C- = compounds.
c = critical state.
L = liquid state.
m = molecular
n = plate number counted from the top.
o = at the weir overflow.
v = vapor state.

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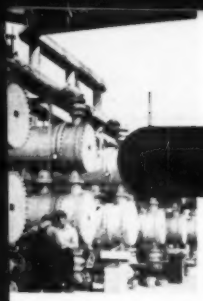


PLANT PRACTICES

Practical Tips and Ideas for Improving Operations

Automatic Samplers Help Check Waste Contaminants in Various Plant Areas

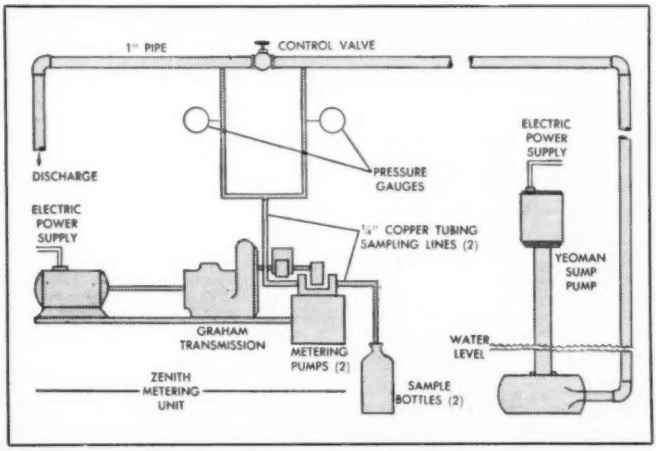
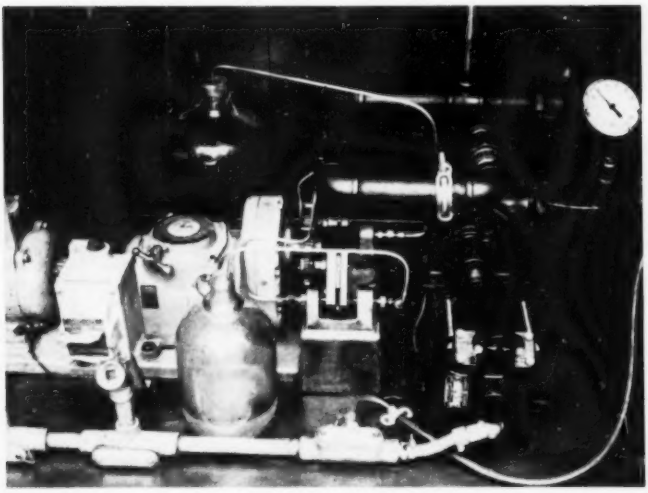


FIG. 1—Isometric sketch of design used on permanently installed compositing sample machines



THIS PORTABLE WASTE SAMPLER enables Indiana Standard to make rapid checks on sewers in any part of Whiting refinery

AUTOMATIC compositing sample machines installed at various locations on lateral sewers at the Whiting, Ind., refinery of Standard Oil Company (Indiana) have been a material aid to the operating department in determining the amounts of contaminants originating in different areas throughout the plant.

The machines, developed and designed by the Research Department of the company for the waste disposal program at Whiting, were assembled from standard, commercially-available pumps and parts. They were evolved over a number of years, during which time machines of various designs were tested. The present design, illustrated in the isometric sketch in Fig. 1, has proved quite reliable in service. It consists of a conventional sump pump pulling a stream from the sewer through a 1-in. line, with a ¼ inch bypass line from which a composite sample can be accurately metered, according to sampling requirements.

Specifications for the sump pump are: Yeoman Bros. Co., SD-6, Model B; single, vertical, submerged type, centrifugal; requiring an 1800 rpm., ½ hp. motor for drive. The Zenith Metering Unit is designated as a 2 QE Laboratory metering unit. Other pumps and metering units would undoubtedly be suitable, Indiana Standard points out, providing they are equivalent in performance.

In addition to these permanent type machines, the company is using a portable unit for checking sewers at any desired location in the refinery. This machine, shown in the photograph, utilizes an Aurora Model D4, bronze, turbine type, self-priming pump in place of the Yeoman sump pump employed on the permanent machine. The entire assembly is mounted in a small covered trailer for quick mobility.

Double Layer of Insulation Decreases Fire Hazards

APPLICATION of molded insulation in two layers instead of a single layer of equivalent thickness will result in a more efficient and, where any fire hazard exists, a safer, installation, according to the Magnesia Insulation Manufacturers' Association.

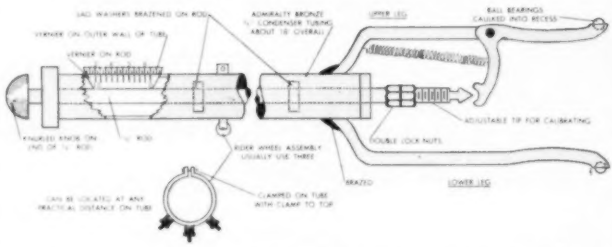
Expansion and contraction of high temperature equipment often will

cause joints between insulation blocks or sections to open, it is pointed out. Enough heat can then escape through such cracks to reduce materially the effectiveness of the installation.

Open joints are particularly dangerous in a fire hazard area, such as a refinery, where a leak or break in an adjacent pipe or vessel would allow escape of flammable fluids.

The recommended double layer insulation permits the use of staggered joints and prevents these troubles. After the first layer is wired on, the sections or blocks in the second layer are applied so that each joint is centered over a block or section underneath.

Simple Gage for Furnace Tubes



A SIMPLE tube gaging device, built in the maintenance shops of the Linden, N. J., refinery of Cities Service Oil Co., has been providing very satisfactory service for routine inspection of 4-in. furnace tubes. Shown in the sketch (scale exaggerated for greater detail), the tool will measure differences in inside diameter from about 3⅝ to 4½ in. The vernier has been calibrated to indicate diameter differences of 0.1 in. Operation of the device can be readily understood by study of the drawing. It was designed under the supervision of Fred Arnold, mechanical foreman at the Linden plant.

Slurry Bundle Cleaning Time Reduced by 80%

BOILING water under relatively high pressure serves as a rapid means of cleaning out slurry bundle tubes in the Fluid catalytic unit at Esso Standard Oil Co.'s Baltimore refinery. Boiler department men have found the method will slice the time required for cleaning by over 80%. In the case of a bundle with 400 tubes they can clean one tube per minute. They have found they can do a complete job in 8 hours as against a 48 hour operation when using conventional air driven tube cleaners.

It has been found the deposit can be easily driven out by water at 180° and about 180 psi. pressure. This water is introduced into each tube in the bundle through a ⅜ inch diameter pipe which forms a jet. This small pipe is made long enough to reach through the 16-foot exchanger tubes. Experienced personnel prefer this method to the previous one employed. The deposit apparently is easily dislodged by the water jet and driven out of the tube.

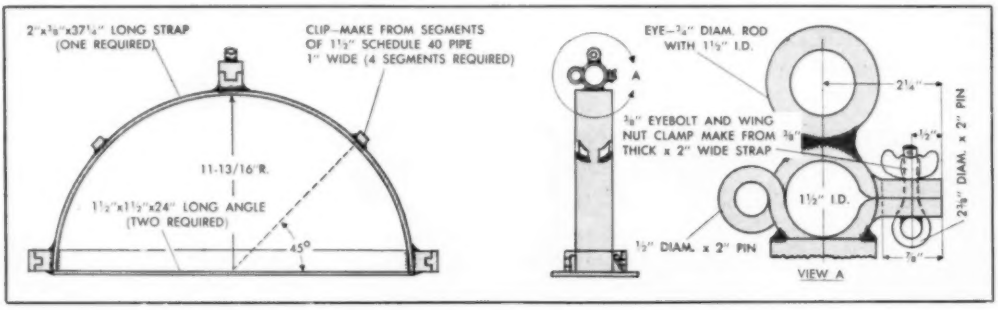


FIG. 2—Lifting rig which reduced damage to "rattling hoses" used to clean surface tubes at Socony's Augusta refinery

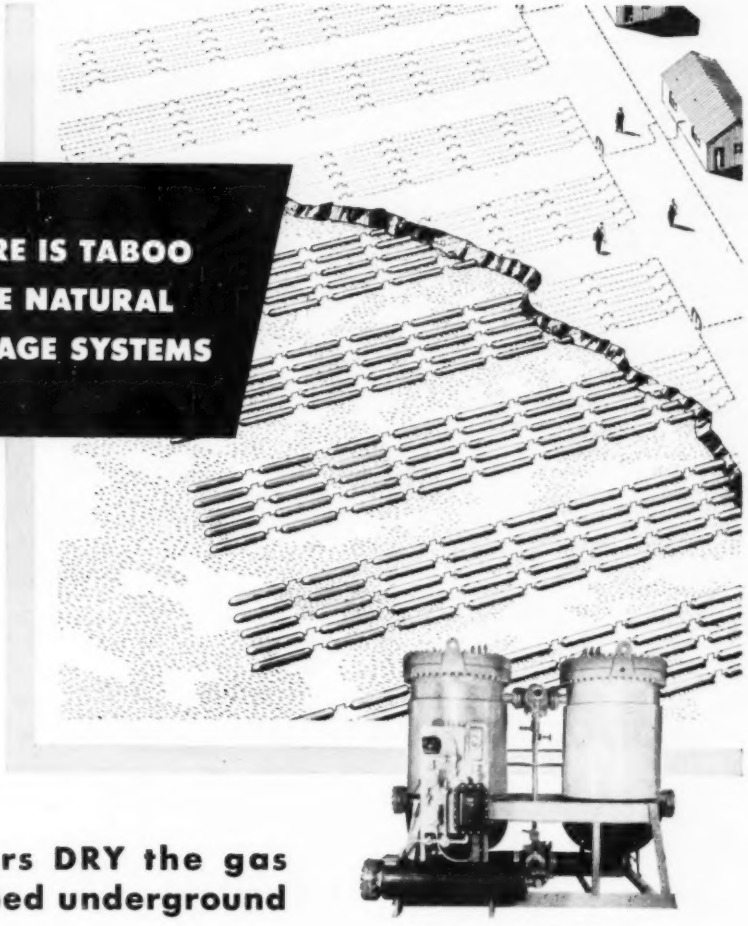
Lifting Rig Prevents Damage to Hose Used to Clean Vertical Furnace Tubes

RATTLING hoses" used for cleaning tubes in Petro-Chem furnaces at the Augusta, Kans., refinery of Socony-Vacuum Oil Co., Inc., formerly were breaking every time the tubes were cleaned. This condition was being caused chiefly by the simple lifting clamp which permitted the hose to kink and break easily.

A shop-built lifting rig was designed to replace the clamp. It prevented damage by distributing the stress from lifting over a greater length of the hose. The new rigs have been in use about a year with no further broken hoses occurring.

As shown in the several views in Fig. 2, this rig consists of a piece of 2 x ⅜ in. steel bar bent on a 12-in. radius and having attached to it two 1½ x 1½ x 3/16 in. angle for stiffening purposes. Attached to the bent bar are three clamps formed of strap iron to hold the hose to the frame. One clamp is welded at each end of the semi-circular piece and one is welded to the midpoint on top, where a ring is attached for engaging the hook on the rope blocks. In use, the hose is laid over the frame and held in position by the clamps. The rope blocks are attached to the ring on top for lifting and lowering the rattling gear through the furnace tubes.

MOISTURE IS TABOO IN THESE NATURAL GAS STORAGE SYSTEMS



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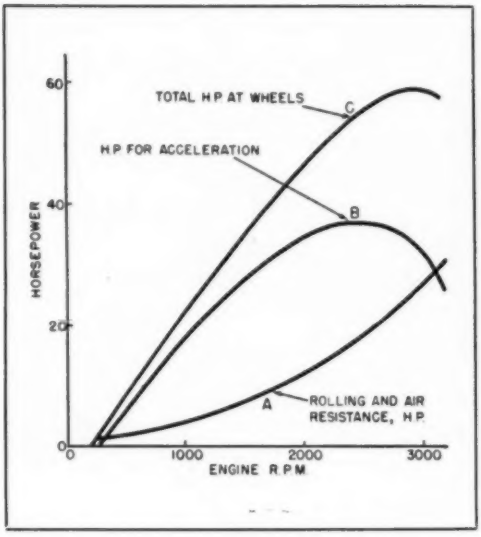

FIG. 1—*Automobile performance curves for a standard 1946 Chevrolet in high gear on level road*

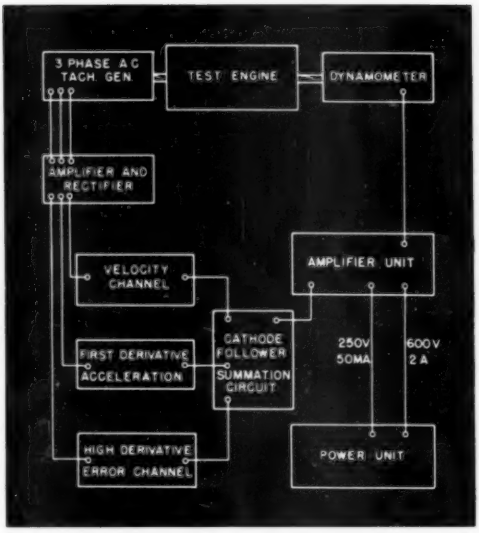

FIG. 2—*Block diagram of the electronic road load control circuit, essentially a closed servo-mechanism*

Laboratory Engine Load Controller Simulates Actual Road Conditions

From a Report by **A. R. ISITT, M. R. WALL, and A. G. CATTANEO***
Shell Development Co., Emeryville, Calif.

An electronic-type dynamometer control has been constructed by Shell Development Co. which automatically imposes on a laboratory engine the same load which would be encountered when the engine was installed in any car. Fuel and lubricating oil tests can be performed by manual or program-control operation of the throttle, without the hazards, discomforts and uncontrollable road and atmospheric conditions experienced in actual road ratings. Test fuels have been road and laboratory rated with satisfactor agreement of data so that all advantages of laboratory rating work can be coupled to following experimental and commercial fuels and lubricants.

THE "compromise" character of laboratory knock procedures using single-cylinder engines to indicate the road quality of a fuel has long been accepted by refiners. With general agreement, the laboratory procedures are suitable principally for plant control purposes. Development of the Uniontown and Borderline road knock rating methods has been of great value in assisting the refiner to fit his fuels to the car engine throughout its speed range by proper blending of stocks. But in turn they too have presented problems.

Performing these latter tests on the highway with a high degree of reproducibility and repeatability is difficult, owing to the lack of control of such variables as ambient temperature and wind direction. In addition, the aural detection of knock is made difficult by wind and road noises. These require operation with closed windows, causing observer discomfort in warm weather. Furthermore, traffic hazards are numerous and the conduct of these tests requires abnormally good driving skill and caution.

Such tests are most easily handled in the laboratory, thus overcoming these difficulties, especially when a large number of fuel samples must be tested. However, the test engine would have to be operated at the same acceleration rates and loadings encountered on the road. Various control devices have been developed —such as prearranged programs through relays, which were essentially controlled rheostats in the dynamometer field circuit. All have permitted only the execution of program scheduled in the control. Many also had other limitations.

Shell Development Co. has developed an Electronic Road Load (ERL)

* Condensed from a paper presented at the Nat'l Fuels & Lubricants Meeting, Society of Automotive Engineers, Tulsa, Okla., Nov. 9-10, 1950, under the title: "An Engine Dynamometer Control for Fuel Evaluation by Simulated Road Tests."

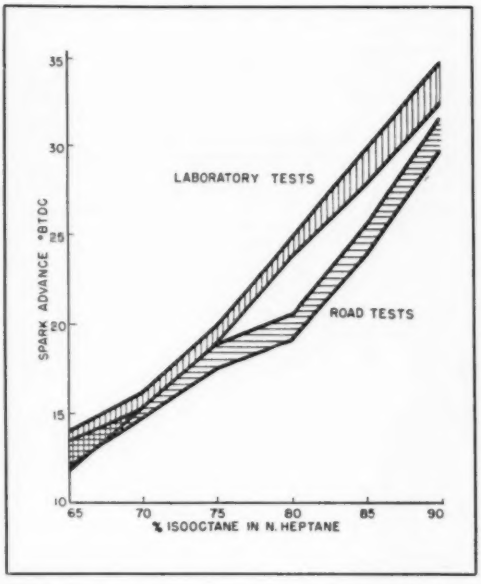

FIG. 3—*Knock curves under the Modified Uniontown Method for the reference fuels, road tests and ERL control*

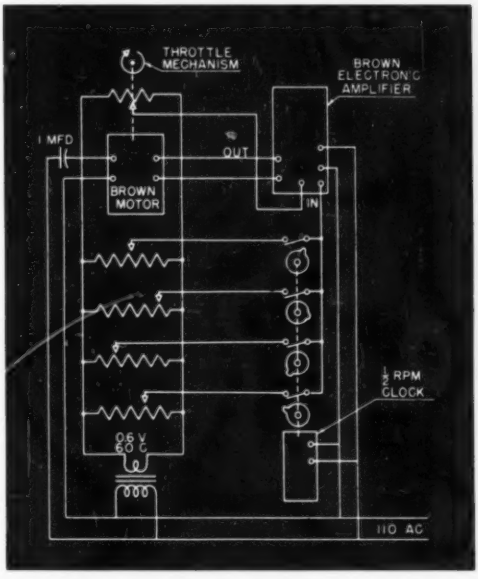

FIG. 4—*Block diagram for the electrical circuit of the automatic throttle program controller*

control which accomplishes operation of the test engine under road load by applying to the laboratory engine a dynamometer load substantially identical to road conditions.

It is capable of reproducing the combined inertia and resistances of a car in high gear, regardless of before and after events, and can be used for any desired test schedule. All that is necessary is to operate the throttle exactly as it would be in a car on the road.

The ERL control was developed primarily for fuel rating under full-throttle acceleration. However, it is equally useful for fuel rating under any other conditions. Combined with a cycling throttle control, it can simulate stop-and-go driving or any other cycle.

The ERL Control

In high-gear, level-road car operation, the engine at any one speed is subjected to both constant and variable loads. The constant load, represented by Curve A, Fig. 1, comprises the rolling plus air resistance of the car. The variable load is the inertia of the car. The difference between available engine power, Curve C, and the constant resistance, Curve A, is the maximum power available for acceleration, Curve B. The general shape of these curves is the same for all vehicles, but their absolute values will depend primarily on engine power and car weight.

Curve A is available from numerous references and car manufacturers' data, and must be duplicated in form by the dynamometer control. Adjustment also must be provided to vary the end-value of this curve to compensate for variations in engine power and car weight.

Fig. 2 is a block diagram of the electronic solution to this control problem. Essentially it is a closed servo-mechanism in which a speed-sensitive tachometer generator on the test engine shaft provides a signal to the control circuit and from there to an amplifier which supplies field current to the dynamometer. Since the load on a car at any instant during acceleration is a summation of velocity (or resistance) load plus acceleration (or inertia) load, the control similarly has a velocity and an acceleration channel. These channels, plus a third "error" channel, are all similar in design.

Velocity channel output is a high impedance direct voltage, proportional to engine speed. Since acceleration is the first derivative of velocity, a voltage representing the acceleration can be obtained by differentiating the velocity voltage. The output of the

TABLE 1—Test Fuel Compositions and Properties

Fuel Blend No.	1	2	3	5	9
Composition, Vol.-%					
Light straight run	47	47	47	...	...
Light thermal	...	...	...	47	...
Light soda treated cat. cr.	...	...	...	...	48
Heavy straight run	47	...	...	46	47
Heavy acid treated thermal	...	47	...	...	...
Heavy hydrogenated cat. cr.	...	...	46	...	...
n-Butane	6	6	7	7	5
Gravity, ° API	57.5	56.2	53.8	57.7	56.5
RVP	8.0	8.0	8.8	7.9	8.0
Distillation, ASTM					
IBP, ° F	107	112	92	100	107
FBP	384	373	391	389	383
10% Evaporated	148	150	143	136	135
50%	262	258	255	261	265
90%	352	334	357	353	352
% Rec.	97.0	97.0	97.0	98.0	98.0
ASTM Gum, mg./100 ml.	1	1	3	1	2
F-2 Octane No.:					
0.0 cc. TEL/gal.	62.5	68.2	74.3	69.9	73.4
1.5 cc. TEL/gal.	73.5	76.2	82.9	77.0	78.4
F-1 Octane No.:					
0.0 cc. TEL/gal.	64.3	73.0	81.6	74.1	83.7
1.5 cc. TEL/gal.	74.8	81.8	90.0	83.7	91.2

derivative circuit of the acceleration channel, consisting of a capacitor and resistor in series, should then be a high impedance direct voltage, proportional to engine acceleration. The error channel provides a high order derivative signal to prevent any sudden accelerations. It is necessary because the high value of inductance in the dynamometer field winding resists the rapid change in the field current required at the start of an acceleration run. A Type 6J5 tube, operating at reduced filament voltage, converts the summation of these high impedance voltages to a low impedance signal for the dynamometer rectifier.

The amplifier design is complicated by the high value of inductance of the dynamometer field winding. This high inductance was overcome by causing the output current to follow the control signal. Generally, amplifier circuits produce output voltages which follow the control signal.

A full-throttle, speed-time curve was obtained for a 1946 Chevrolet standard coupe on the road, using an Esterline-Angus recorder actuated by an AC tachometer generator. A duplication of this curve then was attempted in the laboratory by proper design of the velocity and inertia channels in the dynamometer control.

Accuracy of duplication and reproducibility was satisfactory except at the extreme low speed end, where the high inductance of the dynamometer field precludes rapid enough loading of the engine to prevent overspeeding. The mechanical inertia of the dynamometer rotor evidently has little effect here with its low polar moment (16 lb.-ft.)

In general, velocity loading affects the high speed end, and acceleration loading affects the low speed end. Once these adjustments are made, the engine under ERL control can be operated by its throttle alone, responding as it would in its car at high gear on a level road. Idling, acceleration at part or full throttle, cruising at constant speed, and various rates of deceleration are obtained as a fully automatic response to throttle manipulation. The three channels are provided with independent adjustments, having sufficient range to handle any make automobile and any size dynamometer. Operation on a constant grade can be simulated by suitable increase of the velocity component.

A limited knock test program was carried out on a 1942 Chevrolet engine to check the reproducibility and accuracy of the ERL control. Iso-octane and n-heptane reference fuels and five fuels from an earlier road test program were run. The five fuels were made up from straight run, thermally, and catalytically cracked components.

Each fuel was tested unleaded and with 1.5 cc. TEL per gal., thus providing 10 test fuels. The inspection data are shown in Table 1. There was wide enough variation in sensitivity to establish the differences in multi-cylinder octane ratings under constant speed and accelerating conditions. All were rated by the Modified Uniontown Test and the Borderline Road Test methods, using aural detection.

Knock Test Results

In the road tests the car was accelerated repeatedly from 10 to 60 mph. under full throttle, and spark was adjusted until a "trace" knock was obtained with each fuel. The spark reading was obtained at a constant speed of 30 mph., with a Sun stroboscopic light flashing on fly-wheel graduations. This reading was then referred to a spark advance vs. octane number curve set up by reference fuel blends and the octane rating of the fuel obtained.

In the laboratory, this test was duplicated with the ERL control by accelerating the engine from 500 to 3000 rpm. Test data are given in

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Fig. 3 for the reference fuels, both from the road tests and the dynamometer control for different test days, under the Modified Uniontown Method. The reproducibility of the ERL is notably as good as the road tests, although the ERL control average curve is higher.

Other detailed data and curves, not included with this condensation of the paper, indicated that laboratory reproducibility was better than that obtained on the road. Certain ramifications of the road test make for poor reproducibility and repeatability, particularly the factor of extraneous noises. This problem is still present in the laboratory, but differently from on the road. The Chevrolet engine in the laboratory produces a "ping-like" noise under detonating conditions which interferes greatly with establishment of borderline knock. Insulating the engine to reduce the interference and the use of electronic detonation indicators promises to overcome this difficulty.

Other Types of Tests

The ERL control may be extended to provide any cycle of operation by an automatic throttle control, a simple throtte program timer being capabe of duplicating any desired cycle.

Recently it was desired to operate a laboratory engine to simulate city driving. To obtain the necessary record of throttle action, a Chevrolet was fitted with a throttle position recorder and numerous records were obtained over a 5-mile course. These records indicated the actual throttle opening and time between openings, corresponding to changes in operating accompanying gear shifting. From many records a device was deveolped to produce the average pattern on a laboratory engine.

The throttle program controller (shown in the block diagram, Fig. 4) consists of a standard Haydon program timer with four adjustable cams driven by an 0.5 rpm. clock motor which gives a two minute recycling program. The desired time interval for each element of the throttle sequence is set on the appropriate adjustable cam, which operates a microswitch. The amplitude of each program element is handled by a self-positioning electronic servo-system in which a Brown "Electronik" amplifier, from a potentiometer recording instrument, drives a Brown pen motor connected to the throttle mechanism.

The switch selects one of four variable resistances, preset to the desired amplitude, and the motor runs until the variabe resistance on the motor shaft reaches the same amplitude. There is a finite time required for the throttle positioning motor to find the new position, and a compromise exists between the size of the motor and speed of operation. The Brown pen motor can make a full throttle change in about 1 sec.

Ice "Dripper" Holds 77° Temperature on Hot Days

CONTROL laboratory personnel at the Linden, N. J., refinery of Cities Service Oil Co. have worked out a novel method for maintaining the constant temperature of 77° F. used in one of the routine tests, particularly when summer brings temperatures above that point.

Normally, the bath is heated by immersion electrical heaters. It presents no operating problem during the cooler times of the year. However, in hot weather it tends to move above the required 77° F. To compensate for this condition, a small ice container has been rigged up and mounted above the bath. A number of holes of the proper size as determined by experience are pierced in the bottom of the container. These apertures permit melting ice water to drip into the bath at just the rate needed to keep the bath temperature constant at 77° F.

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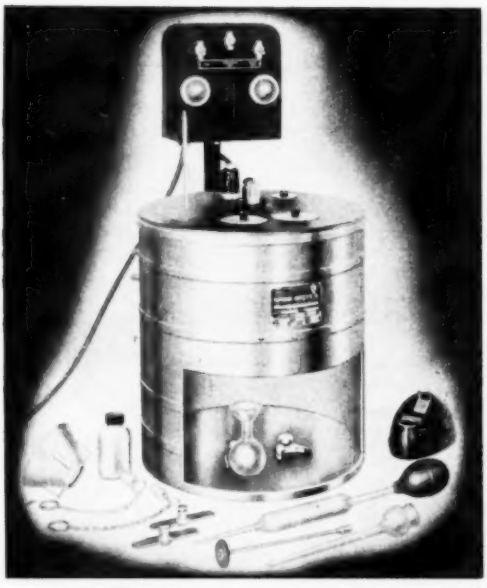

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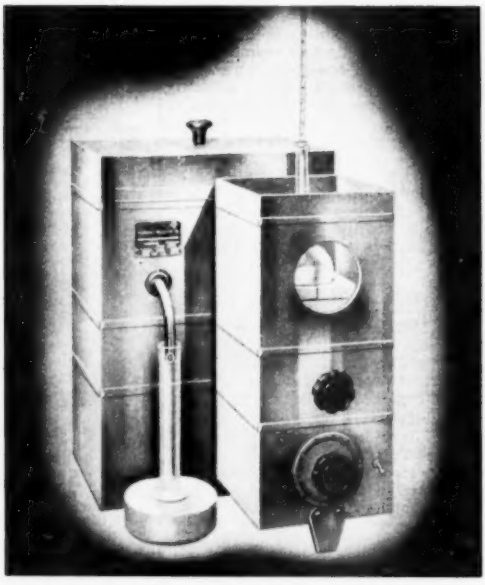

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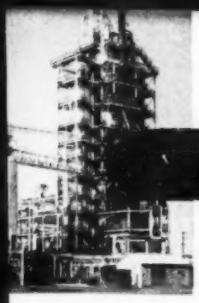


PROCESSING PATENTS

New Developments in Processes and Products

By PETER J. GAYLOR
Editor, "The Technical Survey"

Cracking Oil Stocks for Conversion to Olefins

ONE of the serious drawbacks in processes for converting oil stocks to olefinic gases is the serious carbon deposition involved. According to U. S. Patent 2,525,276 issued to the Hercules Powder Co., if atomized oil at noncondensing temperatures and substantially atmospheric pressure is injected suddenly into a stream of steam within an externally heated alloy tube, the mixture can be supplied with heat during its further passage through the tube to bring about satisfactory cracking of the oil with a minimum of carbon deposition and a maximum of flexibility of temperature, time and pressure control. Even oils containing asphalts are claimed to be used without substantial carbon deposition, and no serious carbon deposition has been found to occur within the cracking tube in commercial size application.

The equipment employed to achieve these results is depicted in Fig. 1. Oil from pump 1 is forced through preheater 2 and into mixer 4 in which it is atomized and partially vaporized with primary steam led in through measuring valve 5. Thereafter, the mixture is led through injection tube 6, the lower portion of which is enclosed in reaction tube 7 maintained in furnace 10. The atomized mixture then is injected through nozzles 9 into a stream of secondary steam, a portion of which is metered through valve 12 and is led into reaction tube 7, while a small portion may be led into space reducer 15 through valve 17 to prevent reaction gases from entering space reducer 13 through perforated plate 15. The cracking of the oil in presence of steam essentially takes place in the annular space between space reducer 13 and reactor wall 7, and the olefinic-containing gases are discharged through outlet 14.

Gas rates of 3940 cu. ft. per 100 lbs. of oil have been obtained containing 18% olefins with a good percentage of acetylene, and 3690 cu. ft. with 20% acetylene and ethylene, which represents a gas production rate of the order of 12,000 cu. ft. per bbl.

Some oils were found to be beneficially cracked 100%, obtaining some 30% or better total olefins and eliminating fractional separation of gas from uncracked oil. Average wall temperatures (reactor) are in the neighborhood of 1650° F.

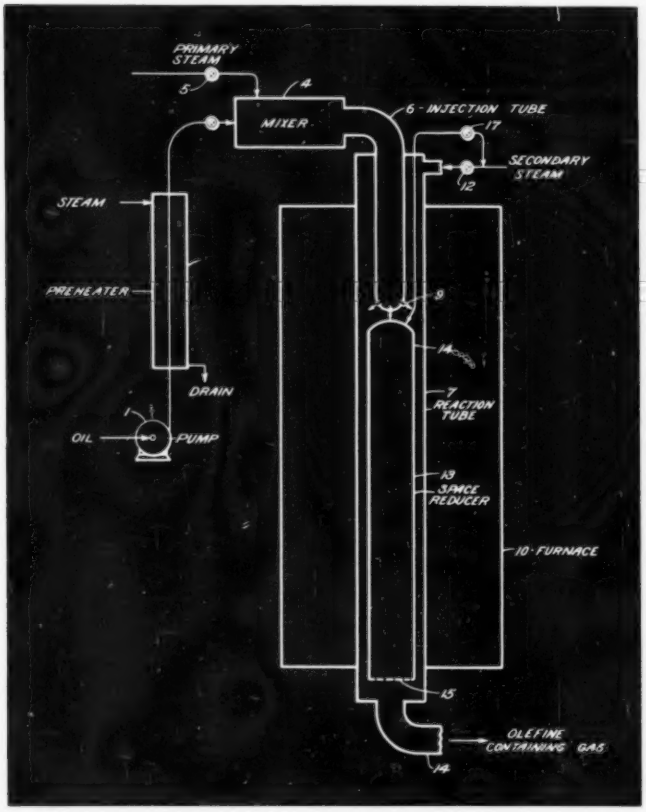


FIG. 1—Equipment developed by Hercules Powder to minimize carbon deposition in cracking oil stocks to olefinic gases (U.S. 2,525,276)

Patents Issued in November

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of direct interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for Nov. 7, 14, 21 and 28, Vol. 640, Nos. 1-4.

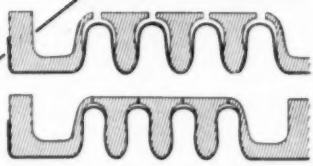
Fuels

2,528,605 (Anglo-Iranian Oil Co.)—Stabilized leaded fuel.
2,529,496 (Standard Oil Co.-Ohio)—Leaded fuel containing organic silicon compound.
2,530,650 (Universal Oil Products Co.)—Metal deactivator.
2,530,931 (General Motors Corp.)—Detonation indicating apparatus.
2,531,001 (Standard-Vacuum Oil Co.)—Airplane fuel servicing unit.

Conversions

2,528,586 (Houdry Process Corp.)—Catalytic desulfurization and cracking of sulfur-containing petroleum.
2,528,693 (Shell Development Corp.)—Aromatic

D-F S-E*



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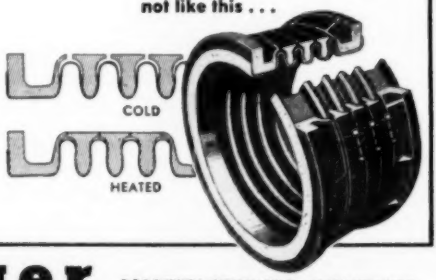

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Processing Patents

hydrocarbons by dehydrogenation of naphthenes (toluene).

2,528,751 (Atlantic Refining Co.)—Acid absorptive alumina.

2,528,767 (Socony-Vacuum Oil Co.)—Drying inorganic oxide gels.

2,528,876 (Standard Oil Co.-Ind.)—Propylene polymerization with HF-BF_3.

2,528,893 (Standard Oil Co.-Ind.)—Ethylbenzene conversion.

2,529,010 (Phillips Petroleum Co.)—Polymerization of olefins with HF and silica.

2,529,293 (Standard Oil Development Co.)—Dehydrogenating paraffins and olefins.

2,529,317 (Standard Oil Development Co.)—Apparatus for conversion of energy in a flowing stream of fluids.

2,529,503 (Sinclair Refining Co.)—Catalytic cracking apparatus.

2,529,520 (Standard Oil Development Co.)—Low temperature polymerization process.

2,529,583 (Universal Oil Products Co.)—Controlling flow of subdivided solid particles.

2,529,598 (Universal Oil Products Co.)—Reactor for high-temperature cracking.

2,529,790 (Phillips Petroleum Co.)—Thermal and catalytic cracking of hydrocarbons.

2,529,843 (Socony-Vacuum Oil Co.) — Contact mass level control.

2,530,143 (Socony-Vacuum Oil Co.)—Recovery and utilization of olefin by an absorption-Alkylation process.

2,530,645 (Universal Oil Products Co.) — Catalyst contacting apparatus.

2,530,874 (Gulf Research & Development Co.) —Isomerizing N-pentane.

2,530,875 (Gulf Research & Development Co.) —Isomerizing light naphtha.

2,531,294 (Phillips Petroleum Co.)—Isomerizing N-butane with $AlCl_3$.

2,531,356 (Socony-Vacuum Oil Co.)—Conversion of asphalt-containing feeds in presence of oxide gel catalysts.

2,531,365 (Socony-Vacuum Oil Co.)—Conducting conversions in presence of a contact mass.

2,532,128 (Sinclair Refining Co.)—Preparing a cracking or reformed feed stock.

Refining

2,528,586 (Houdry Process Corp.)—Catalytic desulfurization and cracking of sulfur-containing petroleum.

2,528,587 (Houdry Process Corp.)—Desulfurizing diesel fuel and similar hydrocarbon fractions.

2,528,751 (Atlantic Refining Co.)—Acid absorptive alumina.

2,529,274 (The Texas Co.)—Solvent refining of low-aromatic oils.

2,529,289 (Standard Oil Development Co.)—Preparation of intermediate fraction with solid adsorbents.

2,529,310 (Standard Oil Development Co.)—Acid-treating contaminated water-immiscible head-forming oil.

2,529,312 (Standard Oil Development Co.)—Liquefaction of methane.

2,529,484 (Phillips Petroleum Co.)—Improving lube oils by treating with HF, alcohol and water.

2,529,624 (Stanolind Oil & Gas Co.)—Revivification of adsorbents.

2,529,670 (Pure Oil Co.)—Sweetening gasoline with caustic and sulfonated wood tar oxidation catalyst.

2,530,129 (Standard Oil Development Co.)—Drying gases with oxide gel.

2,530,274 (Phillips Petroleum Co.)—Pebble heater system.

2,530,300 (Sun Oil Co.)—Separating N-paraffins with activited carbon.

2,530,561 (The Texas Co.)—Removing mercaptans by reacting with ethylene oxide.

2,530,701 (Shell Development Co.)—Desulfurizing gasoline by extracting mercaptans which are converted to H_2S.

2,531,547 (Phillips Petroleum Co.)—Apparatus for washing oils with an immiscible wash liquid.

2,531,723 (Phillips Petroleum Co.)—Improving lubricating oils by treating with HF and silver fluoride.

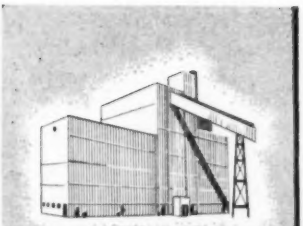
2,531,767 (Universal Oil Products Co.)—Desulfurizing hydrocarbons in presence of hydrogen.

2,532,031 (Shell Development Co.)—Separation of C_9H_{10} aromatic hydrocarbons by extractive distillation.

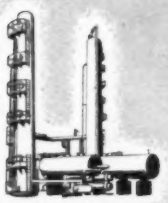
Chemicals

2,528,732 (Socony-Vacuum Oil Co.)—Reaction products of diesters of di-thiophosphoric acid and oils containing same.

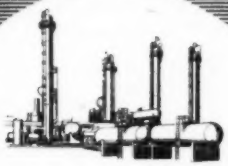
2,528,761 (Union Oil Co. of Calif.)—Azeotropic distillation of ethyl alcohol from methyl ethyl ketone.



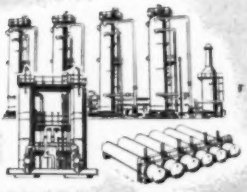
POWER DIVISION



CHEMICAL DIVISION



PETROLEUM DIVISION



NATURAL GAS DIVISION

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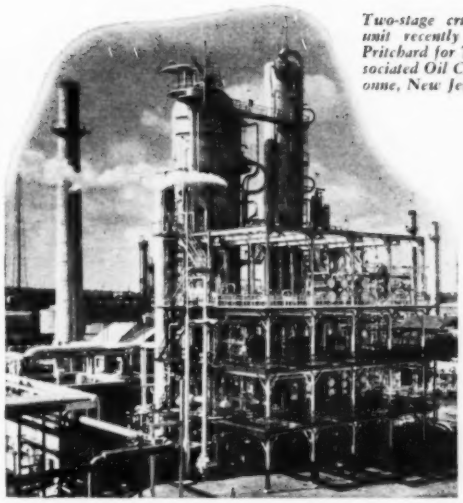

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[To obtain more data on advertised products see page 80]

2,528,769 (Socony-Vacuum Oil Co.)—Reaction product of haloalkylethiophenes and hydroxyaryl compounds.
2,528,789 (Socony-Vacuum Oil Co.)—Benzophenone.
2,528,892 (Standard Oil Co.-Ind.)—Xylenes separation.
2,528,978 (Shell Development Co.)—Synthesis of pyridine bases.
2,529,298 (The Texas Co.)—Sulfuric acid alkylation of thiophene compounds.
2,529,315 (Standard Oil Development Co.)—Amine activated emulsion polymerization.
2,529,316 (Standard Oil Development Co.)—Acylating butadiene styrene copolymers.
2,529,318 (Standard Oil Development Co.)—Low - temperature polymerization at the freezing point of the polymerizate material.
2,529,355 (Phillips Petroleum Co.)—Dialkyl polysulfides.
2,529,538 (Procter & Gamble Co.)—Sulfonation of olefins.
2,529,591 (Universal Oil Products Co.)—Synthetic resins from a dichloroalkane and a hydrocarbon fraction containing chloroaromatic hydrocarbons.
2,529,622 (Stanolind Oil & Gas Co.)—Formaldehyde purification and polymerization with selective condensation of water vapor.
2,530,070 (Shell Development Co.)—Cyclic sulfone amines.
2,530,145 (Standard Oil Development Co.)—Emptying butyl rubber reactor.
2,530,325 (Standard Oil Development Co.)—Azeotropic distillation of mesitylene from isophorone.
2,530,332 (Standard Oil Development Co.)—Separating tert-monohexanes and preparing 2-methylpentanol 2.
2,530,369 (Phillips Petroleum Co.)—Oxidation of aromatic compounds in presence of HF.
2,530,661 (Universal Oil Products Co.)—Ethyl chloride recovery.
2,530,699 (Gulf Research & Development Co.) —Photochemical chlorination of hydrocarbons.
2,530,727 (Phillips Petroleum Co.)—Cyclopentene production.
2,530,757 (Standard Oil Co.-Ind.)—Extracting sulfuric acid sludge for sulfonic acids.
2,530,772 (Standard Oil Co.-Ind.) — Phenolic condensation product.
2,530,953 (Standard Oil Development Co.)—Sulfuric acid recovery.
2,530,954 (Standard Oil Development Co.)—Reducing foam in acid concentrators.
2,530,978 (Standard Oil Development Co.)—Isolating xylene isomers.
2,530,987 (Standard Oil Development Co.)—Unsaturated aldehydes.
2,530,989 (Standard Oil Development Co.)—Synthesis of oxygenated organic compounds.
2,531,063 (Standard Oil Development Co.)—Condensation of acyl polymers with aromatic hydrocarbons.
2,531,166 (California Research Corp.) — Detergent concentrate.
2,531,172 (California Research Corp.)—Isophthalic acid.
2,531,173 (California Research Corp.)—Terephthalic acid.
2,531,279 (The Texas Co.)—Thiophenes from sulfur dioxide and hydrocarbons.
2,531,280 (The Texas Co.)—Alkylation of thiophene compounds.
2,531,284 (Imperial Chemical Industries, Ltd.) —Butanols from butenes.
2,531,324 (California Research Corp.) — Alkylated aromatic hydrocarbons and their sulfonation.
2,531,327 (California Research Corp.)—Vinyl xylenes.
2,531,328 (California Research Corp.)—Indenes.
2,531,361 (Ethyl Corp.)—Recovery of chlorinated hydrocarbons.
2,531,403 (Phillips Petroleum Co.)—Coagulating a latex of a sulfur dioxide resin.
2,531,601 (The Pure Oil Co.)—Mercaptan synthesis.
2,531,602 (The Pure Oil Co.)—Thioethers and mercaptans.

Lubricants

2,528,732 (Socony-Vacuum Oil Co.)—Reaction products of diesters of di-thiophosphoric acid and oils containing same.
2,528,773 (Socony-Vacuum Oil Co.)—Mineral oil lubricants containing sulfur compounds.
2,528,782 (Socony-Vacuum Oil Co.)—Lubricant containing wax-substituted thiophene.
2,528,785 (Socony-Vacuum Oil Co.)—Lube oil containing alkyl aminobenzothiophenes.
2,529,188-91 (Gulf Research & Development Co.)—Lubricating metal surfaces during cold working.
2,529,300 (Standard Oil Development Co.)—Lube oil containing pour inhibitor.
2,529,302 (Standard Oil Development Co.)—Oil stabilized with P-S compound.
2,529,304 (Standard Oil Development Co.)—Extreme pressure lube containing condensation product.
2,529,523-4 (Sinclair Refining Co.)—Lube oil containing sulfonate detergent.
2,530,339 (Standard Oil Development Co.)—Compounded hydrocarbon products.
2,530,804 (Automatic Electric Labs., Inc.)—Lubricating compound containing lube oil, wax, aluminum soap, polycarboxylic acid, and dibutyl.
2,530,837 (Gibson Products Co.) — Water-soluble lubricant containing high-titre soap, borax, and inorganic compound.
2,530,838 (Gibson Products Co.)—Wire, rod and sheet metal drawing lubricant.
2,531,129 (American Cyanimid Co.)—Mineral lube oil containing dialkyl dithio phosphoric acid—formaldehyde condensation product.
2,531,446 (National Lead Co.)—Bodied lubricant containing base-exchange clay containing onium base and swellable in nitrobenzene (Bentone greases?)

Hydrocarbon Synthesis

2,529,630 (Stanolind Oil & Gas Co.)—Synthesis gas manufacture.
2,530,243 (Standard Oil Development Co.)—Hydrocarbon synthesis.
2,530,344 (Standard Oil Development Co.)—Hydrocarbon synthesis with spherical catalyst particles.
2,530,345 (Standard Oil Development Co.)—Spheroidal Fischer-Tropsch catalyst.
2,530,977 (Standard Oil Development Co.)—Fluidized hydrocarbon synthesis process.
2,530,998 (Standard Oil Development Co.)—Hydrocarbon synthesis.
2,531,420 (Hydrocarbon Research, Inc.) — Catalytic reduction of carbon oxide by hydrogen.

Specialties

2,528,932-4 (Shell Development Co.)—(Adhesive) compositions containing glycidyl ethers.
2,529,322 (Standard Oil Development Co.)—Synthetic drying oils.
2,529,590 (Universal Oil Products Co.)—Hydrocarbon drying oil

Catalysts

2,529,236 (Shell Development Co.)—Reactivation of cobalt oxo catalyst.
2,529,283 (Standard Oil Development Co.)—Silica-alumina-magnesia catalyst.
2,531,112 (California Research Corp.)—Regenerating HF catalyst.

Miscellaneous

2,530,144 (Standard Oil Development Co.)—Cleansing of polymerization reactors.
2,530,320 (Standard Oil Development Co.)—Corrosion resistant liner.
2,530,463 (Phillips Petroleum Co.)—Continuous sample collecting device.
2,530,976 (Standard Oil Development Co.)—Chilling mixtures.

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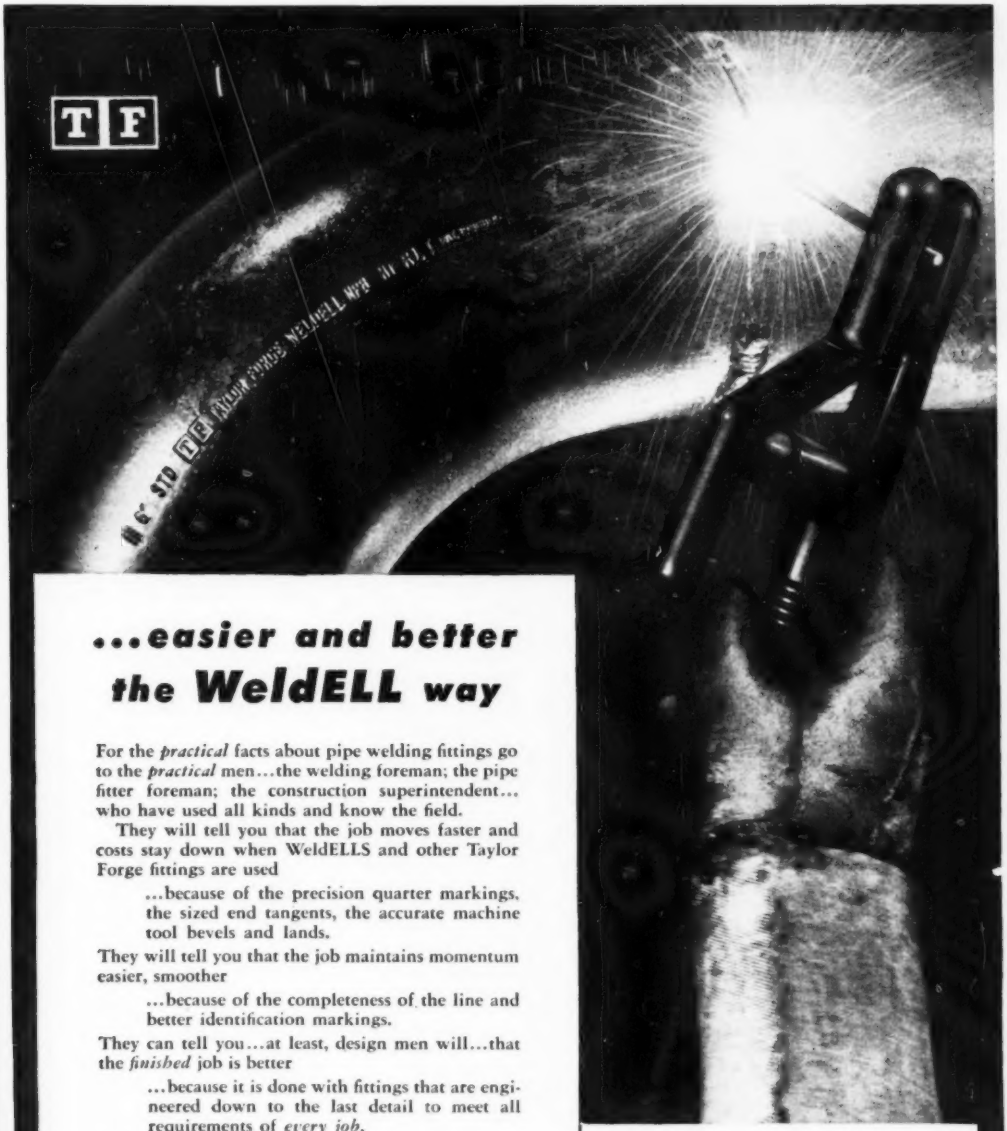

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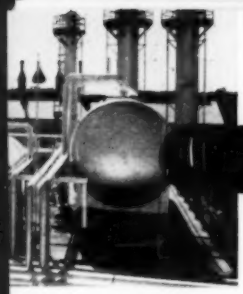


EQUIPMENT PATENTS

Brief Reviews of New Inventions in Equipment

Venturi Flow Control Reduces Erosive Wear from Catalyst

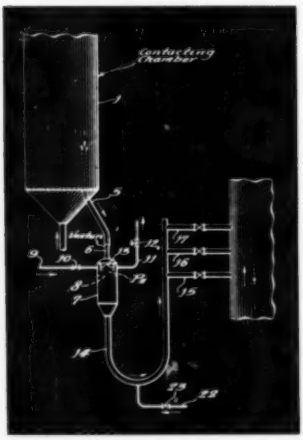


FIG. 1—Venturi restriction 6 provides control of catalyst flow from reactor to regenerator in cracking unit (U. S. 2,529,583)

CATALYST flow rate, in a cracking unit from the reactor to the regenerator for example, can be closely controlled by means of a fixed venturi restriction and adjustable pressure control to eliminate the need for a slide valve, star feeder, or other typical mechanical flow control device. The system is claimed to be less subject to harmful erosion and wear or to plugging and coking such as is encountered in conventional mechanical orifice devices.

The arrangement is illustrated schematically in Fig. 1. Catalyst flows from reactor 1 through conduit 5 and venturi 6 to a receiver 7. A disengaging space in chamber 7 allows particles to settle out in a continuously moving column, the top surface of which is indicated generally by broken line 8.

A fluid inlet line 9 with control valve 10 bleeds in a stream, preferably gaseous—nitrogen, steam or the like—to maintain a given desired pressure in the upper portion of chamber 7. Outlet line 11 with control valve 12 releases the gaseous medium from the chamber. Baffles 13 prevent turbulence at the inlet and outlet connections. The entire fluid bleed-in system provides means for controlling pressure P_2 at the outlet end of venturi 6 and, in turn, maintaining a controlled pressure drop across the venturi.

Maintenance of a desired pressure in the regenerator is obtained by the column of solid catalyst passing from chamber 7 through a U-tube, conduit 14, which effects a pressure seal. Variations in U-tube height as required by variations in operating pressures are obtained by the multiple outlets from conduit 14 to the regenerator—lines 15, 16, and 17. Aeration to prevent clogging in tube 14 is provided by aeration line 22 and valve 23.

In some catalytic processes, where an outside stripper may be desired, this may be combined with the present system by incorporating such stripping action in chamber 7 and using steam as the bleed-in fluid entering through line 9.

U. S. 2,529,583, issued November 14, 1950, to George F. Adams, assignor to Universal Oil Products Co., Chicago, Ill.

Improve Acid Service Liners By Metallic Salt Treatment

POROUS liners of inert materials such as carbon, designed for use in vessels or pipe which are to handle corrosive acids, can be made more resistant to the action of such corrosives by a new method patented recently.

The procedure involves impregnating the liner material with an aqueous solution of a soluble metallic salt which is capable of reacting with the acid to form a substantially insoluble metallic salt by exchange reaction. The insoluble salt remains as a deposit in the pores and interstices of the liner material. An advantage cited for the method is the elimination of lead interliners, costly from the maintenance standpoint as well as initially.

For example, if the acid to be handled is sulfuric, the soluble salt used for the impregnation is lead acetate. This is converted to insoluble lead sulfate by the action of the acid on the liner. The method can be employed on a liner already installed, or the treatment may be given to individual liner elements before installation. Or, if desired, treatments may be repeated after liners have been in service. If initial impregnation has been made to a sufficient depth, erosive action on the liner surface will merely expose fresh areas still treated with the salts.

U. S. 2,530,320, issued November 14, 1950, to Albert Abraham, Jr., assignor to Standard Oil Development Co., New York.

Patents Issued in November

The following classified listing covers patents issued during the month of November, 1950, believed to be of interest or value to petroleum processing or handling operations:

Catalytic Reactors

2,529,503 (Sinclair Refining Co.)—Fluid type catalytic cracking apparatus.
2,529,583 (Universal Oil Products Co.)—Catalyst flow control by use of a fixed Venturi and adjustable pressure control instead of slide valve or other mechanical means.
2,530,558 (Sinclair Refining Co.)—Regenerating kiln for moving bed type catalytic cracking unit.
2,530,645 (Universal Oil Products Co.)—Internal stripper for fluid catalytic cracking unit.
2,531,192 (Socony-Vacuum Oil Co., Inc.)—Bucket type elevator for conveying catalyst in moving bed cracking units.

Processing, general

2,529,598 (Universal Oil Products Co.)—Reactor for high temperature cracking.
2,530,002 (Joseph A. Coy)—Cooling tower spray.
2,530,274 Phillips Petroleum Co.)—Pebble heater system and method of operation.
2,530,320 (Standard Oil Development Co.)—Corrosion resistant liner materials for handling sulfuric acid.
2,530,527 (Celanese Corp. of America)—Reaction vessel for hydrocarbon oxidation in the gaseous phase.
2,530,731 (Phillips Petroleum Co.)—Pebble heating chamber.

Fire Extinguishers

2,529,127 (Cardox Corp.)—Fire extinguishing system using liquid carbon dioxide.
2,529,852 (Ward E. Snowden)—Dual valve nozzle for discharging water and also dry chemicals.
2,530,583 (Ignatius Nurkiewicz)—Hand extinguisher of the sealed pressure type.
2,530,633 (American-LaFrance-Foamite Corp.)—Pyrotechnic-operated extinguisher in which a liquid, such as methyl bromide, is expelled by gas evolved from the burning of a so-called powder grain.
2,531,366 (Victor M. Langsett)—Portable extinguisher of the fog type employing carbon dioxide to exert the required pressure.

Furnaces & Boilers

2,528,564 (Phillips Petroleum Co.)—Furnace for preheating or cracking petroleum products.

Equipment Patents

2,530,958 (Danciger Oil & Refining Co.)—Furnace for heating gases above 2000° F., using refractory in place of metal tubing.

Heat Exchangers

2,529,013 (American Locomotive Co.)—Heat exchanger designed for handling oxygen and nitrogen in liquid form.

2,529,516 (Hydrocarbon Research, Inc.)—Heat exchanger designed for handling oxygen and nitrogen in liquid form.

Instruments

2,528,537 (Houdry Process Corp.)—System electrically responsive to change of level of material in a receptacle; for example, catalyst in a cracking vessel.

2,528,735 (The Foxboro Co.)—Instrument case construction.

2,529,030 (Phillips Petroleum Co.)—Method of distillation control by measuring refractive indexes in side streams.

2,529,254 (Gieley & Mueller, Inc.)—Controller in which pilot valve action can be easily reversed.

2,529,740 (General Controls Co.)—Safety control system for fluid fuel burners.

2,529,843 (Socony-Vacuum Oil Co., Inc.)—Level control for catalyst mass in moving bed cracking units.

2,530,157 (Minneapolis - Honeywell Regulator Co.)—Electric proportioning controller with liquid-operated follow-up.

2,530,463 (Phillips Petroleum Co.)—Device for composite, weighted, and representative, continuous sampling of gases from a flow stream.

2,530,652 (Atlas Valve Co.)—Snap-action valve control mechanism.

2,531,243 (The Texas Co.)—Fuel-air ratio controller for a supercharged fuel-injection internal combustion engine.

2,531,436 (Consolidated Engrg. Corp.)—Apparatus for introducing samples to analyzers such as infra-red and mass spectrometers, without introducing contaminants.

2,531,592 (Mine Safety Appliances Co.)—Apparatus for the analysis of carbon monoxide in the air or other gaseous atmospheres.

2,531,603 (Ralph N. Brodie Co.)—Positive displacement type fluid meter.

2,531,887 (Combustion Engineering-Superheater, Inc.)—Combustion safety control system.

2,532,218 (Mathieson Chemical Corp.)—Self-cleaning capillary tube type flow meter.

Pumps & Compressors

2,528,764 (John T. Leonard)—Reversible flow rotary pump.

2,529,317 (Standard Oil Development Co.)—Use of a multi-stage centrifugal pump as a fluid motor to drive another centrifugal pump.

2,529,349 (Pennsylvania Pump & Compressor Co.)—Centrifugal unloader for compressors.

2,531,726 (Geo. D. Roper Corp.)—Positive displacement rotary pump.

2,531,752 (Economy Pumps, Inc.)—Pumping apparatus for sumps.

2,532,145 (Robbins & Myers, Inc.)—Helical type rotary pump.

Tanks & Vessels

2,531,424 (Chicago Bridge & Iron Co.)—Seal for floating roof tanks.

2,531,897 (Graver Tank & Mfg. Co., Inc.)—Method of making floating roofs.

2,531,898 (Graver Tank & Mfg. Co., Inc.)—Floating roof with flexible deck and central weights.

Tools

2,528,814 (Hugh N. and Elizabeth M. Boyer)—Confronting wrench jaws each having normally aligned work-engaging sections pivotable to Vee-shape.

2,531,039 (George C. Hardie)—Pipe and nut wrench provided with reversible jaw faces.

2,531,746 (E. A. Schumacher and T. R. Breed)—Wrench having cam-lever for swinging and locking a pivoted outer jaw.

Valves & Fittings

2,529,544 (Tri-Clover Machine Co.)—Lift plug valve.

2,529,795 (Melvin L. Bryer)—Gate valve.

2,530,744 (Alexander S. Volpin)—Line pressure lubricated plug valve.

2,531,020 (Francis N. Bard) — Flexible ball joint.

2,531,021 (Francis N. Bard)—Swing joint.

2,531,759 (Reed Roller Bit Co.)—Plug valve.

Miscellaneous

2,529,133 (Crouse-Hinds Co.)—Electrical junction box for explosion-proof installations.

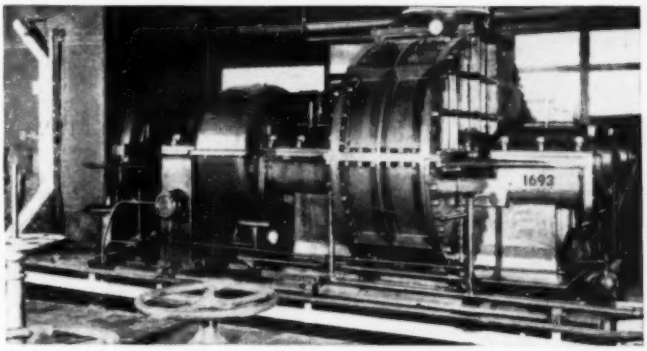
2,531,079 (Crane Packing Co.)—Cooled and lubricated rotary seal.

NEW R·C EXHAUSTER
pays its own way

By replacing a 30-year-old battery of three steam-driven gas exhausters with a new, high-capacity, electrically-driven R-C unit, important advantages were gained, in a large industrial plant:

1. **The one new unit carries the base load.**
2. **Steam needed for 5 other steam-driven exhausters, carrying partial load, is substantially reduced because of slower speeds.**
3. **Heat balance in the plant is maintained.**
4. **Savings in total power cost will pay for the new installation in about one year.**

These very satisfactory results were obtained by careful evaluation of all the factors before deciding upon the type of equipment . . . and then by specifying an R-C Rotary Positive Gas Exhauster that will do the work at low operating cost.



Type RCGH Rotary Positive Gas Exhauster, driven by 450 hp synchronous motor. Capacity, 20,600 cfm.

Even though your equipment to handle gas or air may still have years of life, it may be sound economy to replace it with modern, efficient, R-C units of the right type, size and drives to best meet your needs. Our engineers will help you analyze your problem and make unbiased recommendations of either Rotary Positive or Centrifugal equipment, depending upon your specific conditions. This *dual choice* is an exclusive R-C advantage.

With capacities from 5 cfm to 100,000 cfm, R-C units can be closely matched to work requirements, for dependable, economical performance. At Roots-Connersville, almost a century of blower building experience is at your service, without obligation.

Type OI Centrifugal Blower in oil refinery operation. Capacity 11,750 cfm.

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151 Texas Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

[*To obtain more data on advertised products see page* 80]

The Books Don't Tell All...

SELAS *Gradiation*

NEW CONCEPT OF HEAT PROCESSING IS CHANGING PRODUCTS AND METHODS

It takes more than ordinary armor plate to stop the new bazookas . . . it took new engineering and metallurgy to withstand the heat of "jets." Industrial and military demands are moving ahead so rapidly, products and production methods are changing . . . changing so rapidly, the books don't have all of the answers—can't have all the answers.

Heat processing is a striking example. Selas Engineers found their own answers to better products and methods . . . their engineering far-sightedness developed a new concept of heat processing . . . GRADIATION. A departure from ordinary heating methods . . . it is radiant heat used as a precision tool. Gradiation combines high-temperature radiant gas heat, high-speed automatic operation, precise controllability and protective atmosphere.

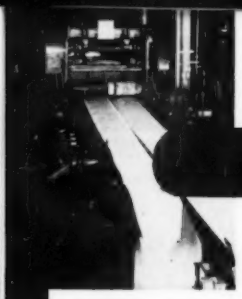
Selas Engineers, utilizing GRADIATION, have designed, built and installed new tubestills that achieve faster heat transfer, more complete combustion in smaller spaces, eliminate hot spots, assure more exact control of temperatures, pressures and timing.

If you are interested in squeezing more out of every drop processed, you'll be interested in discussing *heat processing as a precision tool* with Selas Engineers.

HEAT PROCESSING ENGINEERS FOR INDUSTRY . . . DESIGN, DEVELOPMENT, MANUFACTURE

SELAS CORPORATION OF AMERICA

PHILADELPHIA 34, PENNSYLVANIA



NEWS OF SUPPLIERS

Manufacturers
Distributors
Engineering Firms

Diesel Engine, Pump in Same Room

Safe installation of diesel engines and pumps in the same room has been made possible by use of continuous air sampling and analyzing instruments to detect concentrations of vapors around seals on flammable liquid pumps. This has resulted in substantial savings in space and construction costs and greater convenience in operating and maintenance.

The combustible gas detection and alarm systems are installed in five diesel-powered pumping stations on Shell Oil Co.'s pipe line from Wood River, Ill., to East Chicago, Ind. Seventeen different products, from propane to avgas, are piped simultaneously through the 250-mile line regularly. The detection systems have recently completed two years of successful operation.

Developed by Mine Safety Appliances Co., they are suitable for analyzing most combustible gases and vapors. A ⅜-in. O.D. copper tube carries samples from the space around the pump seals to the analyzer, located about 25 ft. away on the main instrument panel in the pump room. A turbo-compressor with explosion-proof motor draws the samples to the analyzer, which is housed in an explosion-proof case and equipped with flashback arresters.

When vapor concentration reaches 60% of the LEL (lower explosive limit), the analyzer energizes the alarm circuit. This shuts down the station completely and operates a red signal light on the instrument panel. Although the station operator may not be present a drop in inlet pressure at the next station on the line, caused by a pump shutdown, is noticed.

Blaw-Knox Obtains Linde Processes

The Chemical Plants Div., Blaw-Knox Co., has completed arrangements with the Linde Eismaschinen Co. of Germany, authorizing it to design and construct complete plants employing low temperature processes.

Among the important processes made available by this arrangement is one for the tonnage production of oxygen. Plants embodying this process, it is stated, will be engineered to American standards and will require low capital costs and low power consumption. Other processes made available by the arrangement between the two concerns include low temperature separation of industrial gas mixtures and separation of rare gases from the air.

American Cy Expands in Canada

As of January 1, American Cyanamid Co. began distribution throughout Canada of products of two more divisions of the firm, including those of the Industrial Chemicals Division and of the coating resins department of the Plastics and Resins Division. Distribution will be handled by the subsidiary, North American Cyanamid Ltd. at sales offices in Montreal, Quebec (7335 St. Lawrence Blvd.) and in Toronto, Ont. (Royal Bank Bldg.).

As a further step of expansion in Montreal, the company has taken an option on a proposed site for a building or buildings for sales offices and warehouse facilities.

Montgomery Joins Chem Construction

Brigadier General Edward Montgomery, U. S. Army, Ret'd., has been appointed assistant to the executive vice president of Chemical Construction Corp. He retired from the services in 1949 after 23 years with the Chemical Corps. He was technical director in charge of chemical warfare research and development from 1931 to 1935. During World War II he was on the staff of the Commanding General of the Air Force as chemical officer coordinating all chemical warfare work in this branch of the service.

Two California Plants Reactivated

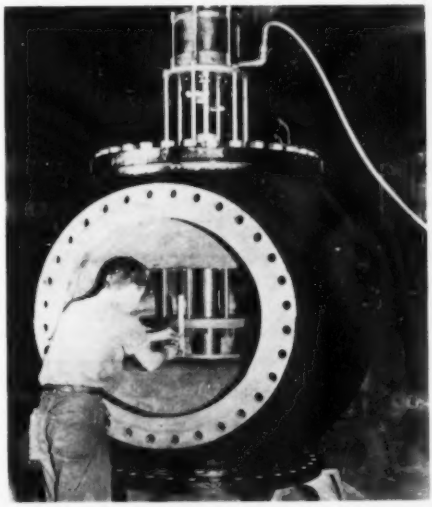
The Petroleum Maintenance Co., Wilmington, Calif., has under contract the reactivation of a catalytic cracking unit for Wilshire Oil Co. at its Norwalk, Calif., refinery.

Petroleum Maintenance recently completed another reactivation project on a large butadiene plant at the El Segundo refinery of Standard Oil Co. of Calif. Idle for several years, the plant was restored to its World War II operational capacity by authorization of the Reconstruction Finance Corp., Office of Rubber Reserve, who selected Petroleum Maintenance for the job.

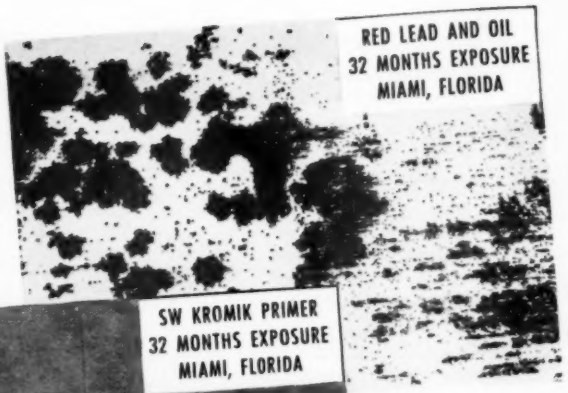
Ladish Opens in Tulsa

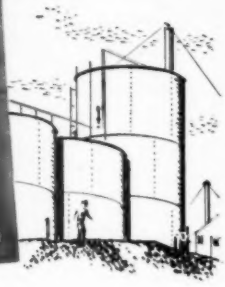
Ladish Co., Cudahy, Wisc., has established a branch office at 405-406 Thompson Bldg., Tulsa, Okla., serv-

What are believed to be the largest double-ported control valves ever built have been completed recently by Kieley & Mueller, North Bergen, N. J. Despite their size (36-in. pipe connections), the huge valves had to fully open and fully close within one second, and provide completely tight shut-off. They are now giving satisfactory service in a large tonnage oxygen plant. Because the valves had to be installed on their sides, the guide posts were equipped with linear-type roller bearings to permit friction-free movement of the plug.



ONE is good... FOUR are BETTER!





INDUSTRY'S FIRST CHOICE
PROTECTIVE PRIMING COAT FOR

TANKS
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STRUCTURAL STEEL
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RIGS
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PUMPS
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ALL INTERIOR OR EXTERIOR
STEEL SURFACES
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SHERWIN-WILLIAMS
S-W KROMIK PRIMER

with FOUR protective pigments—gives longer-lasting, lower-cost protection

Red lead alone provides protection as a primer—but red lead combined with three other active protective agents provides even tougher, longer-lasting, lower-cost protection!

That's why Sherwin-Williams KROMIK Primer offers greater resistance to moisture, rust and corrosion for tanks or any metal structures, as the exposure test panels above prove. Zinc chromate inhibits corrosion . . . zinc oxide adds strength and hardness to the film . . . red lead fortifies the water and corrosion resistance . . . iron oxide adds protection against sunlight and greater covering power. Application difficulties, excessive weight and high costs of heavy red leads are avoided.

S-W KROMIK Primer is just one of a complete line of Sherwin-Williams Maintenance Finishes engineered and proved for petroleum industry service. Ask for them—specify them—through your S-W representative, or write The Sherwin-Williams Co., Transportation Division, Cleveland 1, Ohio.

SHERWIN-WILLIAMS
MAINTENANCE FINISHES FOR THE PETROLEUM INDUSTRY

ing that area with the firm's line of forged and seamless welding pipe fittings. The office is under the managership of George E. Mahoney, who for the past three years has been district manager in Chicago.

Simultaneously, Ladish announced a change in address of the St. Louis office and the appointment of W. H. Heckenberg as district manager. New address in St. Louis is Suite 1605, Continental Bldg., 3615 Olive St.

Howard Promoted at Ethyl

Mr. Howard

John R. Howard, III, has been named coordinator of technical publicity at the Ethyl Corp. Research Laboratories, Detroit, by Ben H. Weil, supervisor of the information division.

Mr. Howard, formerly assigned to the technical service division, joined Ethyl in 1932 after studying mechanical engineering and business administration at Harvard University. He will be responsible for initiating and coordinating the development of technical publicity according to the needs of the various departments of the company. He will also be responsible for editing *Technical Service* and related publications, and will coordinate the Laboratories' exhibits and demonstrations.

Brown Expands Plant Facilities

Brown Instruments Division, Minneapolis-Honeywell Regulator Co., is expanding its production facilities in Philadelphia by the purchase of the three-story, re-enforced concrete structure of Thomas M. Royal Co. and also about 60,000 square feet of undeveloped property adjacent to the new site. Partially occupied by Brown on December 15, complete possession is anticipated by next February following modernization to meet special requirements. Employment in the company is nearing the 2,000 mark, about 300 persons, or 20% more than World War II peaks.

Cochrane Acquires Metal Supplier

Cochrane Corp., Philadelphia, has announced acquisition of Pottstown Metal Products Co., Pottstown, Pa., to be operated as an independent subsidiary. Organized in 1927, the Pottstown company has been one of Cochrane's principal sources of metal for the water conditioning and power plant equipment in manufactures.

Cochrane's president, T. E. McBride, became president and treasurer of the metal firm; V. A. Rohlin

HAVE YOU SEEN THIS NEW BOOKLET?

Condensed information on the function, applications and resultant economies obtainable through this modern development in Entrainment Separation.

The effectiveness of METEX MIST ELIMINATORS has been demonstrated by installations of several years' standing both in this country and abroad. Used in vacuum pipe stills, scrubbing towers, knock-out drums, evaporators and similar equipment and equally adaptable to new or existing installations, they have effected such marked economies as:

1. 95% or better entrainment removal
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Write for your copy today. The coupon below is for your convenience. No obligation, of course.

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I would like to have a copy of your new booklet, Metex Mist Eliminators
Name.....Title.....
Company.....
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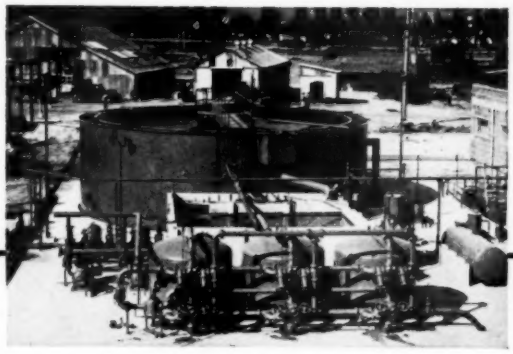
[*To obtain more data on advertised products see page* 80]

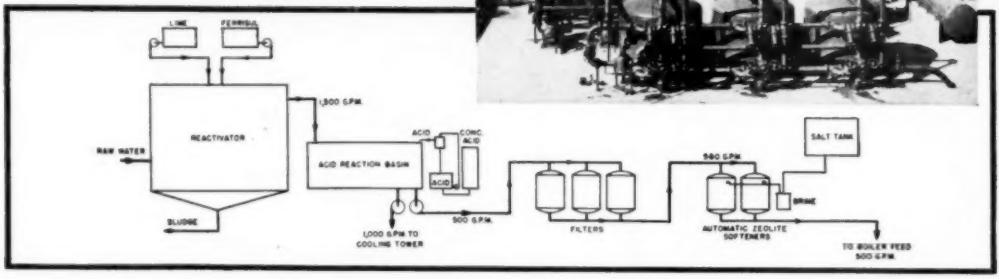
How Tide Water Oil Uses

GRAVER

FOR

COMPLETE WATER TREATMENT





At Tide Water Oil Company's Avon, California, refinery a turbid hard water supply is completely conditioned for boiler feed and cooling water services by Graver equipment consisting of Reactivator, Acid Feeding System, Anthrafilt Filters and Automatic Zeolite Softeners as shown in the flow chart above.

The raw surface water, with an inlet turbidity of 250 ppm, is first treated with lime and ferric sulfate in the Graver Reactivator. Here, partial reduction of hardness takes place while the turbidity is reduced to 3-5 ppm.

The Graver Acid Feeding System continuously and automatically proportions acid to the Reactivator effluent to reduce the alkalinity and to correct the pH to the desired value. Part of the water is thus conditioned for the cooling water system. The remainder of the water is filtered in the Graver Anthrafilt Filter and softened to zero hardness in the Graver Zeolite Softener for use as boiler feedwater.

The completeness of GRAVER service on this job is further accentuated by the facts that GRAVER:

1. **recommended to the Engineers the most effective type of equipment for their requirements.**
2. **built all the major component parts of each Water Treating Unit in its own shops.**
3. **furnished all needed accessories.**
4. **supervised the installation of the equipment.**

This *single responsibility* assures satisfactory operation of every GRAVER installation.

For best results in solving *your* water treatment problem, get the benefit of GRAVER'S 40 years of specialized experience, proven designs, and unequalled facilities. Be sure to ask for GRAVER recommendations.

GRAVER WATER CONDITIONING CO.

216 West 14th Street, New York 11, New York, U.S.A.

CHICAGO • PHILADELPHIA • CLEVELAND

GW-415

GRAVER

A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

is vice president, Raymond A. Piersol is vice president and general manager, and George Mease is plant superintendent.

L&N Buys Additional Space

Acquisition of approximately 85,000 sq. ft. of additional floor space by Leeds & Northrup Co. will increase the company's Philadelphia manufacturing facilities by 28%, to a total of almost 10 acres. The addition is in two parcels. One is a three-story, 50,000 sq. ft. building at Castor and Sedgeley Avenues. The other property totals 35,000 sq. ft. at Collum and Rubicam Sts. Some operations will be transferred; however, the principal manufacturing and other activities of the firm will continue to be centered at the main plant, 4901 Stenton Ave.

Personnel Changes

Selas Corp. of America—David G. Reynolds, recently a petroleum process engineer with Lummus Co., has been appointed to the staff as petroleum engineer in the refinery division.

Edward Valves, Inc.—William G. Mahlman, for three years supervisor of order analysis for both Edward and Nordstrom valves, has been promoted to sales office manager for Edward at East Chicago, Ind.

Eggelhof Engineers—Al Deckert has joined the organization in the New Orleans office as sales engineer in the Louisiana, Mississippi, and Alabama areas covered east of New Orleans. Henry Turner, district manager, will devote his time to the Louisiana territory west of and including New Orleans.

Enjay Co., Inc.—A. Bruce Boehm has been appointed assistant general sales manager for this chemical products marketing affiliate of Esso Standard Oil Co. Sidney W. Fay will succeed him as sales manager of the Paramins Division.

Chicago Bridge & Iron Co.—W. H. Woleben has been transferred from the general sales office in Chicago to the Houston sales office, located in the National Standard Bldg.

Expansion, Transition

Baldwin Locomotive Works has taken over the assets and business of **Lima-Hamilton Corp.** and will, under the name of **Baldwin-Lima-Hamilton Corp.**, now carry on all the activities formerly conducted by both companies.

Born Engineering Co. has sold its oil and gas laboratory to **Tulsa Testing Laboratory, Inc.**, 609 Peoria Ave., Tulsa, according to a joint announcement by Dr. Sidney Born, and J. B. Davis of Tulsa Testing. T. L. Carson, who has been in charge of the laboratory under the Born organization, has transferred to the new owner.

H. K. Porter Co., Inc., Pittsburgh, has announced the formation of Jarecki Valve Division at Tulsa, Okla., to handle the manufacture and sale of Jarecki valves formerly produced at Jarecki Mfg. Co. in Erie, Penna. The products will be made at Porter's Hinderliter Tool Co. Division plant and distributed through Jarecki stores, jobbers, and the main plant.

Rockwell Mfg. Co.—W. F. Weimer, associated with the firm for more than ten years in sales and advertising functions, has been named advertising manager. He succeeds William A. Marstellar, who has resigned as vice president to establish the Marstellar Co., marketing and advertising consultants.

SAVES TANKS - SAVES STEEL

Having new tanks treated by NATASCO is the sure way of getting the ultimate in use from them over a long period of years. Old tanks will also give many years additional service by receiving the proper NATASCO treatment. NATASCO protects the steel surface from all corrosion. Due to the increasing shortage of steel, and its rising cost, NATASCO service provides substantial savings.

SAVES OIL

Evaporation of volatile fractions and loss through leakage has accounted for smaller profits in many oil firms. In most cases *this loss could have been prevented if the tanks had been serviced by NATASCO.*

SAVES DOLLARS

If you have added additional years of service life to your tanks and have eliminated loss by evaporation and leakage, *you have added profits to your business.*

Every NATASCO job is Guaranteed

Wire, Write or Telephone for complete information on how NATASCO can solve your corrosion problems.

PROTECTS TANKS AGAINST CORROSION

The Natasco Company

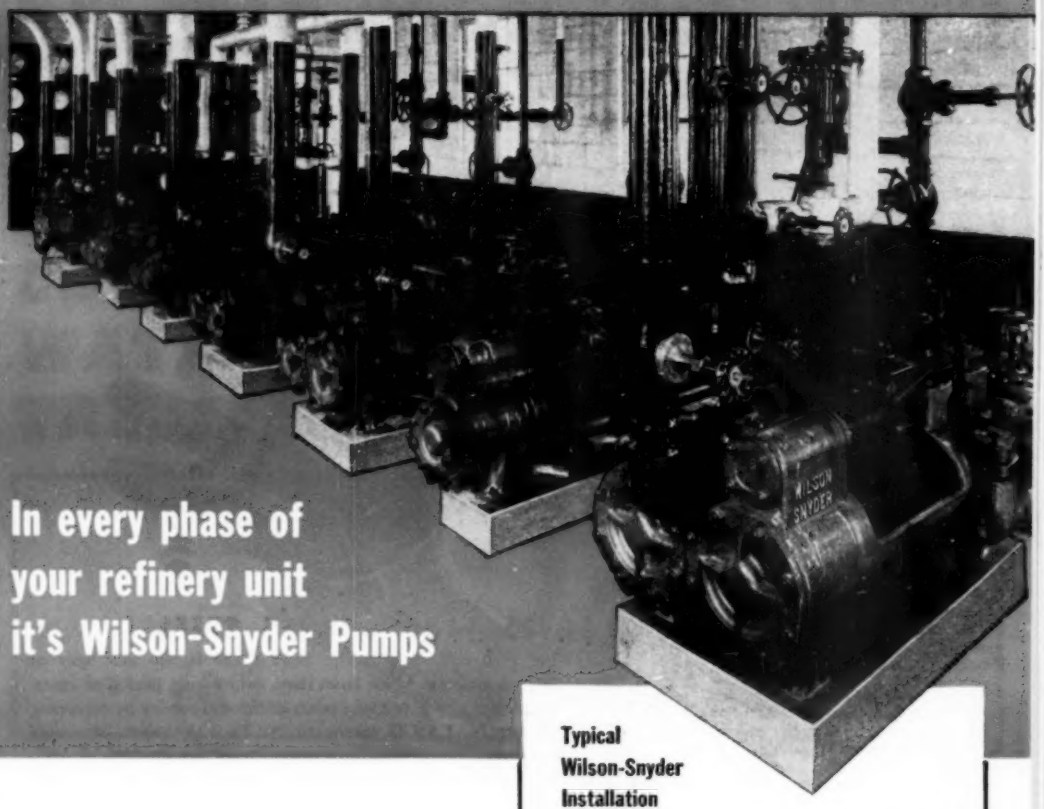
P. O. BOX 1218 TULSA, OKLAHOMA

Lease Tank Service—West Texas Area: Williams Construction Company, Odessa, Texas

California Representative: Coast Contractors, Ltd., 4636 E. Slauson, Maywood, Cal.

[To obtain more data on advertised products see page 80]

For Quality... Dependability... Economy and Service



In every phase of your refinery unit it's Wilson-Snyder Pumps

Wilson-Snyder builds modern pumps for all types of Refinery Service.

Reciprocating Power Driven Pumps—Duplex or Triplex with roller bearing or mill bearing power ends. Arranged for electric motor, steam engine, turbine or internal combustion engine drive.

Steam Driven Pumps—Duplex and simplex piston or plunger types.

Centrifugal Pumps—Horizontal, single stage; single suction or double suction. Horizontal, multi-stage, single suction. Vertical single and multi-stage.

Bring your Refinery Pump problems to "Oilwell" and let us assist you in making the proper selection of a Wilson-Snyder Refinery Pump to suit your particular needs.

Typical Wilson-Snyder Installation

showing one section of a 1700 B.P.D. Dubbs Cracking Unit. Complete Unit Comprises—

1 — 7 x 4½ x 10 Duplex Residuum Pump.
1 — 5¼ x 16 Duplex Forged Steel Charge Pump—Diesel Engine Drive.
1 — 4 x 12 Duplex Forged Steel Charge Pump — Diesel Engine Drive.
1 — 10 x 6 x 10 Stabilizer Reboiler Pump.
1 — 10 x 6 x 10 Duplex Fractionator Charge Pump.
1 — 7 x 4½ x 10 Duplex Absorber Draw-off Pump.
1 — 10 x 6 x 10 Duplex Reflux Pump.
1 — 10 x 5 x 10 Duplex Spare Reflux Pump.
1 — 10 x 5 x 10 Duplex Stabilizer Charge Pump.
1 — 7 x 5 x 12 Simplex Stabilizer Reflux Pump.
2 — 6 x 4 x 6 Duplex Fuel Oil Pumps.
2 — 6 x 4 x 6 Duplex Boiler Feed Pumps.
1 — 6 x 4 x 6 Duplex Caustic Pump.
1 — 12 x 2 x 12 Simplex Ram and Test Pump.

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Branches Serving All Oil Fields

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LOS ANGELES, CALIFORNIA

USS "OILWELL"

UNITED STATES STEEL

Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Most of the Questions and Answers presented here were transcribed from wire recordings made by *Petroleum Processing* at various meetings—the NGAA annual meeting at Ft. Worth, the NGAA regional meeting at Amarillo, and the Instrumentation Symposium at Texas A & M College. Publication is made possible through the cooperation of the various authorities participating.

LPG Pipe Lines

How can an LPG product pipe line change the marketing picture?

Any pipe line changes the marketing picture by whatever changes it makes in transportation costs. In the case of LP-Gas, the freight rates from the manufacturing areas in which most of them are produced into the markets into which most of them go are in the order of 3c per gal. or thereabouts. If a well-loaded products line were handling LP-Gases you would expect a decrease in transportation cost of approximately 2c per gal.—S. S. Smith Shell Oil Co., New York. ("Information Please" session NGAA annual meeting, Ft. Worth, April 26, 1950)

Control Valve Packing

What are the advantages and recommended practices when using "Teflon" valve packing?

"Teflon" is a fluorine plastic, one of the newest developments in the packing field. It may be used for applications involving temperatures up to 500° F. and, with fins on the stuffing box to keep temperature below this value, in even higher temperature service applications. It is chemically inert to most common chemicals except molten caustic.

When properly used with due allowance for temperature growth, it offers extremely low leakage with a minimum of stem friction. It may show slightly higher friction forces than a loosely-fit, well-lubricated conventional packing, but when such a stuffing box is tightened to hold 150 psi. gas pressure, it has been found that on the average the friction will be only about 20% of conventional packing.

The life of Teflon v-ring packing is long. The average service life has not been determined. If corrosion of stems is not present there is every reason to believe it should last five to ten years without further operator attention.

Stem finish is highly important. It should be of the "Superfinish" classification, not rougher than 6 to 8 micro-in., R.M.S. It is our belief that, in most cases, if the packing is ever to be replaced it will be necessary to replace the valve stem also, since it likely will be worn to the extent that the surface finish will be too rough to give good service with minimum leakage.

When Teflon is used as a replacement packing, not only must the stem diameter be correct for the moulded packing but the outside diameter of the packing and inside diameter of the stuffing box must be correct. It has been further found that the inside finish of the stuffing box should be a smooth machined surface, not rougher than 40 to 60 micro-in., R.M.S.—P. A. Elfers, Fisher Governor Co., Marshalltown, Ia. (Portion of paper "Application of Control Valves and Regulators in High Pressure Natural Gasoline Plants" at N.G.A.A. Amarillo Meeting, Dec. 8, 1950.)

Gas Engine Speed Controlled by Pressure

How would the control system you have proposed, combining proportional and derivative responses and proportional and automatic reset responses in a "two-band controller, apply to advantage in a system which includes a pressure control which sets the speed control of a gas engine?

This is one of the particular applications in which we believe this controller will show its greatest merit because speed control is notoriously difficult, due to the very rapid responses which must be secured. Those who have tried to substitute instrument-type control for hydraulic governor-type control know that sometimes in substituting an instrument there are great difficulties, particularly in picking up load changes quickly enough.

The new control system, with derivative action designed into it ("Transet Tri-act Controller"—Ed.) is designed to fit this type of application as readily as it does temperature flow or pressure. It is of great advantage because of the come-up or start-up problems encountered on most engine controls, since it prevents over-peaking and narrows the throttling range while at the same time corrects for load changes.—R. E. Clarridge, Taylor Instrument Co., Rochester, N. Y. (Instrumentation Symposium, Texas A & M College, Oct. 13, 1950.).

'Optimum' Controller Settings

Is it easier to arrive at optimum settings with the new control system than with the conventional pneumatic control system?

It is much easier to arrive at satisfactory settings. I don't know whether it is easier to arrive at "optimum" settings or not, because the controller is much less sensitive to changes in settings. In the equations given in my paper it was found that we wanted to eliminate the 1-RT function in the denominator, because otherwise it set the sensitivity up so rapidly as R and T changed that it was very necessary to arrive at "optimum" settings. In other words, the very best setting for the control was penalized terrifically.

With the proposed controller, the stability curve for the settings do not "peak" in the same way they did before. Therefore this controller can be adjusted through quite a wide band and substantially "optimum" results obtained.

Here "optimum settings" are not as important because the control peaks gradually; the controller can be set in this wide band and results secured which are substantially duplications of one another. But, it might be just as hard—or harder—to find "optimum" as it was before because there is no sharp peak to look for.—R. E. Clarridge, Taylor Instrumentation Symposium, Texas A & M College, Oct. 13, 1950).

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You are apt to see this sign anywhere. It might be on a 'dozer "hogging out" a raw site for a refinery in Europe or the Near East; or on a 100-ton vessel in transit to South America, Canada, or the Orient; or on the control board of a petroleum chemical plant on the Gulf Coast. It might even be as close as the cover of a proposal lying on your own desk.

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BOOKS

Coal-to-Fuel Gas Economics Studied by Battelle Institute

Economics of Fuel Gas from Coal, John F. Foster and Richard J. Lund, Editors; 6 x 9 in., xvi+289 pages, illustrated, indexed, stiff cloth binding, $5.00 (1950). McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 18, N. Y.

About two years ago Battelle Memorial Institute undertook a study of the economics of producing fuel gas from coal as an assignment from the Gasification and Carbonization Committee of the Technical Advisory Board of Bituminous Coal Research, Inc., the research agency of the bituminous coal industry. The result of this project is *Economics of Fuel Gas from Coal*, an evaluation of the technical and economic factors affecting the commercial manufacture of fuel gas from coal.

Survey results, as reported in this book, have been divided into two main parts. The first deals with the technical aspects and includes information on operating costs, maintenance, and investment cost of gasification processes, and on current research. The second part assembles data on costs of transporting various fuels, and discusses supplies, demand, and prices of oil, gas, and coal, in the past. From these data, and from a consideration of consumer preferences, and probable future supplies, an attempt is made to predict price trends for each fuel in the future.

As has been expressed in these columns before, it must be reiterated now that it is indeed unfortunate that so much time apparently must elapse in the preparation of a book for final publication. This volume represents, in the main, information available through the end of 1948. Because of the marked changes in the petroleum field during the late winter and spring of 1949, the editors tried to bring this picture up to date to April, 1949. Time limitations precluded revising all data in the survey as of that date. Nevertheless, the actual publication still consumed over a year more from the time the major portion of the data was assembled.

Granted, a book publisher must sacrifice timeliness for completeness and conversely, a magazine publisher must yield completeness to obtain timeliness. Obviously there is a need for both types of literature in today's rapidly moving business, economic, and social world. A subject like the sources of energy definitely requiries an occasional comprehensive survey, particularly of the technical developments. Unfortunately, the economic side is such that much of what was written a year ago becomes antedated rapidly by newer developments. For that reason, the reader of this present book must supplement the information on the economic phases and temper his own conclusions by a careful study of current information from periodical literature.

The editors are members of the staff of the Battelle Memorial Institute. Investigations of the technical phases of the survey were made by Battelle men under the guidance of Mr. Foster, while economic phases of the work were reviewed and summarized by Institute people with the help of Mr. Lund.

Thorough World Geography Of Petroleum Is Published

World Geography of Petroleum, edited by Wallace E. Pratt and Dorothy Good; 6⅝ x 9¾ in., xvii+464 pages, illustrated, indexed, stiff cloth binding, $7.50 (1950). Princeton University Press, Princeton, N. J.

Geography brings a new viewpoint to the study of petroleum, particularly on a global basis as in this survey by the American Geographical Society, *World Geography of Petroleum*, illustrated profusely with 50 specially prepared maps, 11 diagrams, and 98 excellent photographs.

Divided into four parts, the book includes an introductory section dealing with petroleum in the ground, geological causes of its occurrence, how it is found by the sciences of geology and geophysics, and statistical data on reserves and the extent of exploration. The second part discusses briefly and concisely the functional organization of the petroleum industry—development, production, storage, transportation, refining, and distribution.

The major portion of the volume is devoted in the third part to all the great productive regions and the problems of geology, topography, climate, vegetation, accessibility, population, and cultural and industrial development. Three chapters of particular interest to the future of the industry describe areas in the world which up to the present have only been scratched—the polar territories and the continental shelves.

Petroleum utilization, where it goes, the rates and kinds of production and consumption, and how these rates are changing, constitute the main theme of the fourth part. A geologist, a military spokesman, two geographers, and an economist survey the situation in 1938, in 1939-45, and in the postwar years up to 1949.

The editors were well qualified for the task of preparing this book. Wallace Pratt is a leading petroleum geologist. Dorothy Good is editor, special publications, for the American Geographical Society. Many universities, petroleum companies, organizations, and scientists aided the editors in their work, including two oil industry magazines, *National Petroleum News* and *World Oil*.

ASTM Issues 1950 Edition Of Petroleum Standards

A.S.T.M. Standards on Petroleum Products and Lubricants (With Related Information), 1950 Edition; American Society for Testing Materials Committee D-2; 6 x 9 in., 763 pages; in heavy paper cover, $5.50; in cloth cover, $6.15. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Penna.

Prepared by Committee D-2 on Petroleum Products and Lubricants, this latest compilation (November, 1950) of the *ASTM Standards* presents in their most recent form: 125 standards, including 112 test methods; 8 specifications, 3 lists of definitions relating to petroleum, specific gravity, and rheological properties of matter; 2 tentative recommended practices for the purchase of uninhibited mineral oil for use in transformers and in oil circuit breakers, and for designating significant places in specified limiting values; and other material. The tests for knock rating of engine fuels and certain sampling and volume measuring standards are not included and are issued in special manuals.

New material includes tentative test methods for: askarels; boiling point range of polymerization-grade butadiene; carbonyl content of butadiene; factors and tables for volume correction and specific gravity conversion of liquefied petroleum gases; phosphorus in lubricating oils, lubricating oil additives, and their concentrates; apparent viscosity of lubricating greases; acidity of residue from distillation of gasoline and petroleum solvents; water tolerance of aircraft fuels; analysis of 60 octane number isooctane-normal heptane ASTM knock test reference fuels blends by infrared spectrophotometry; 1,3-butadiene in C_4 hydrocarbon mixtures by ultraviolet spectrophotometry; heptane number, kauri-butanol value, and nitrocellulose diluting power of hydrocarbon solvents.

Appendices include, in addition to the report of Committee D-2, proposed methods of test for: hydrocarbon type analysis of diesel fuels by silica gel adsorption; bromine number of petroleum distillates (color indicator and electrometric methods); refractive index and refractive dispersion of hydrocarbon liquids; density of knock test standard normal heptane and isooctane; pour stability characteristics of winter grade motor oils; reduced pressure distillation of petroleum products; and proposed definitions and specifications for tractor fuels.

There are also recommendations on

the form of ASTM methods of test for petroleum products and lubricants; list of proposed methods prepared by Committee D-2 and published as information prior to 1950, and of other ASTM publications on petroleum products and lubricants; and regulations governing Committee D-2.

Distillation Equilibrium Data Assembled in Single Volume

Distillation Equilibrium Data, by Ju Chin Chu, R. J. Getty, L. F. Brennecke, and Rajendra Paul; 6 x 9 in., vi + 304 pages, stiff cloth binding, indexed, $6.00. (1950). Reinhold Publishing Corp., 330 West 42nd St., New York 18, N. Y.

Dr. Chu and his co-workers have assembled in *Distillation Equilibrium Data* a reference volume that should be of considerable help to engineers concerned with the design, prediction of performance, and study of operating characteristics of distillation equipment in the petroleum and the chemical industries.

The data in the tables comprise all pertinent experimental results of work done throughout the world and is up-to-date as of the end of 1949. The tables which comprise the entire book are divided into three sections, for binary, ternary, and multi-component systems, for a total of 176 systems. A complete formula index at the end of the book facilitates locating any particular system. Original references for all data are given.

Dr. Chu is associate professor of chemical engineering, Polytechnic Institute of Brooklyn, and has authored articles in PETROLEUM PROCESSING. Robert J. Getty and Llewellyn F. Brennecke are chemical engineers with Aluminum Ore Co., St. Louis, and Rajendra Paul is a teaching fellow at Brooklyn Polytechnic Institute.

European Refinery Expansion Reported by Economic Office

First Report on Co-ordination of Oil Refinery Expansion in the O.E.E.C. Countries; 8 x 10¾ in., 87 pages, soft paper binding, (1949), $1.25. Columbia University Press, 2960 Broadway, New York 27, N. Y.

This report on oil refinery expansion by the Organization for European Economic Co-operation comprises the first to be released official statistics regarding this phase of European industrial recovery.

The first part is devoted to such points as the position of oil in modern economy, consumption in the participating countries, method of supply and the need for European refineries, refinery expansion plans as submitted to the OEEC, an assessment of the overall program, etc.

This is then followed by detailed studies on each of the countries participating, which includes Austria, Benelux, Denmark, France, Greece, Iceland, Ireland, Italy and the Free State of Trieste, Norway, Portugal, Sweden, Turkey, the United Kingdom, Trizone (Germany).

Mines Bureau Issues Part I In Hydrogenation Bibliography

Bibliography of Pressure Hydrogenation, Part I, Review and Compilation of the Literature on Pressure Hydrogenation of Liquid and Solid Carbonaceous Materials, Bulletin 485, by J. L. Wiley and H. C. Anderson, Bureau of Mines, Research and Development Branch, Office of Synthetic Liquid Fuels. The first of a three-part report listing and abstracting all available literature and patent data on this subject, including captured German documents.

The bulletin is not for sale by the Mines Bureau. It can be obtained only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $1.25 each.

Government Publications

Energy Uses and Supplies, 1939, 1947, 1965, Information Circular 7582, October, 1950, by Harold J. Barnett, Dept. of the Interior, Bureau of Mines; 8x10½ in., 53 pages, heavy paper binding.

Crude Oil and Refined Products Pipe-Line Mileage in the United States, January 1, 1950, Information Circular 7585, October, 1950, by A. T. Coumbe and I. F. Avery, Dept. of the Interior, Bureau of Mines, 8 x 10½ in., 8 pages, heavy paper binding.

Oil Shale in Spain, Report of Investigations 4736, October, 1950, by H. M. Thorne and A. J. Kraemer, Dept. of the Interior, Bureau of Mines, 8 x 10½ in., 21 pages, heavy paper binding.

Order copies of the above booklets from the Bureau of Mines, Publication Office, 4800 Forbes St., Pittsburgh 13, Penna.

The German Chemical Industry, A Bibliography of the Chemical, Metallurgical and Process Industries, PB 101 458; compiled by L. Wilson Greene of Army Chemical Corps.; 396 pages, $10.00. Orders should be addressed to the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D.C., and should be accompanied by check or money order payable to the Treasurer of the United States.

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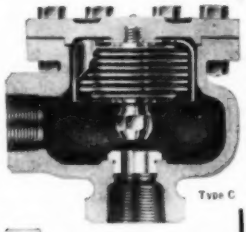

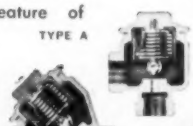

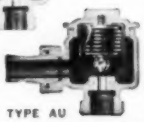

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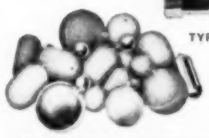

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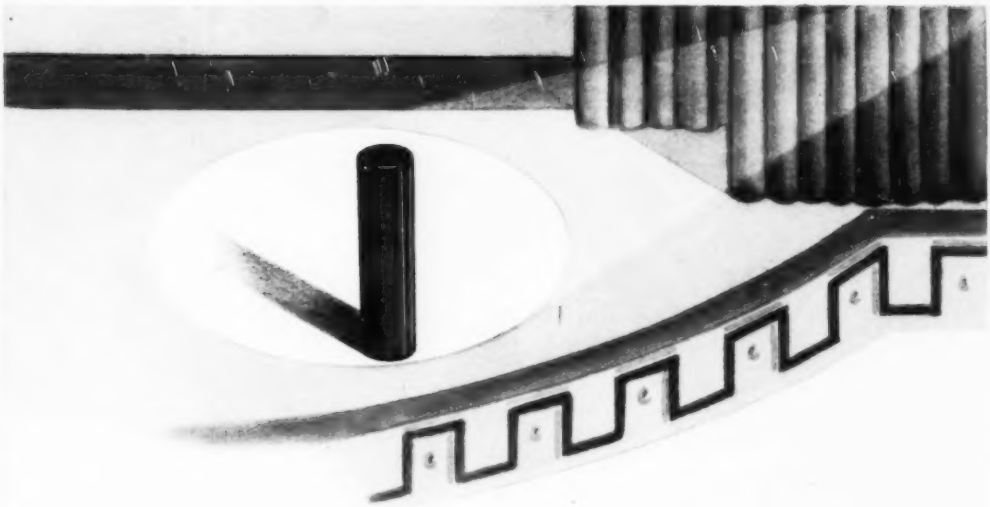

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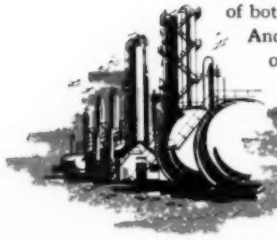

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Heavy Drafts on Fuel Oil Stocks In Eastern Refining Districts

LOWER than normal temperatures in the east and middle west through most of December created a record demand for heating oils at refineries, over 2,300,000 b/d avg. for the first three weeks. Top demand in the 1949-50 winter was not much over 1,800,000 b/d avg.

While refinery production of heating oils (kerosine and distillates) in December also was the highest on record, heavy withdrawals on refinery stocks east of California took place, amounting to over 730,000 b/d avg. for the first three weeks. This is the highest stock withdrawal rate experienced by refiners, the rate being only around 500,000 b/d in Dec. '49 for the districts east of California.

The large drafts on heating oil stocks brought the total for the country east of California to 79,957,000 bbls. on Dec. 30 (API data), as compared with actual stocks of around 82,300,000 bbls. on Dec. 31, 1949 (Mines Bureau figures). In the East Coast and Gulf Coast districts, stocks were reduced by around 15% in the 3-week period.

Indicated refinery output of distillates in December was around 1,260,000 b/d avg., also the highest on record, and achieved on slightly lower crude runs than in previous months. Indicated refinery yield of distillates was 21% as against 18.6% in December, '49.

Indicated demand for residual fuel oil at refineries in December also was a record (over 1,800,000 b/d avg.) While refinery supply remained at the high levels of the past few months, withdrawals from refinery stocks for the country east of California were at the rate of around 245,500 b/d avg. over the first three weeks. This contrasts with a 77,000-b/d avg. withdrawal rate in Dec. '49. The heavy drafts brought the total for residual stocks east of California to 24,332,000 bbls. on Dec. 30 as compared with 26,200,000 bbls. on Dec. 31, '49.

Unless unseasonally low temperatures come in January and February authorities do not anticipate difficulty in meeting coming heating oils demand. With the continuing high rate of crude runs and high yields on distillates, the refining industry is regarded in better shape in this respect than in the two previous winters. Recognizing the heavy demand for fuel oils and the large reduction in stocks in December, the Bureau of Mines states: "Supplies of products during the winter should be ample and can be met by a further readjustment in yields between products, or a moderate increase in the amount of crude refined."

Runs to Stills—Crude runs continued at a high rate in December, around 6,000,000 b/d avg., but just under the average for the four past months. Indicated total crude processed was 9.3% higher than in Dec., '49. For 11 months of this year total runs to stills were 7.2% higher than in the same 1949 period; runs of domestic crude being 6.5% higher while the volume of imported crude is 15% greater.

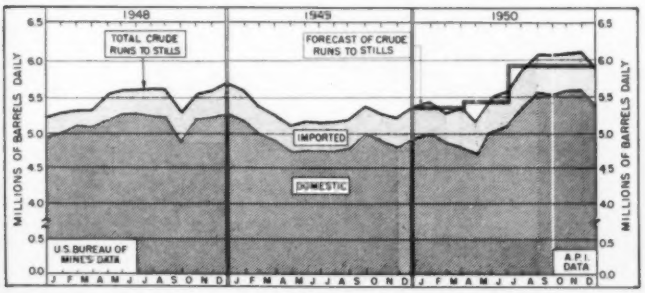
Motor Fuel—Indicated motor fuel demand in December was around 2,735,000 b/d avg., which is within 40,000 bbls. of the November demand. Seasonally, the drop in December from November demand is much larger than this. Also, on the present scale of motor fuel supply-demand operations, the drop in demand in December from the peak of 3,100,000 b/d avg. reached in August is proportionately not as large as in previous years.

These factors, along with other conditions, indicate a continued demand for motor fuel through the early months of 1951 at higher than the normal seasonal rate. The Mines Bureau forecast is for 2,620,000 b/d avg. demand in the first quarter. Indicated demand for December was 9.6% higher than in the same month a year ago and for 11 months of this year demand was 6.7% larger.

Indicated total motor fuel supply in December, 2,910,000 b/d avg., was 8% larger than Dec. '49. Indicated rate of production of gasoline from crude has been over 2,500,000 b/d for the past 4 months, that for Dec. being nearly 7% larger than Dec. '49.

Gasoline stocks early in the year were around 10,000,000 bbls. larger than in the same '49 period. Due to a higher withdrawal rate this year, stocks at the end of December were close to the Dec. 31, '49 level of 111,500,000 bbls.

Fig. 1, Crude Runs Maintain High Level



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Dec. '50 API*	5,475	513	5,988
Dec. '49 BM	4,966	509	5,475
Change	+509	+4	+513
% Change	10.2	0.8	9.3

* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mo. '50*	1,742,951	161,373	1,904,324
11 Mo. '49	1,635,985	139,811	1,775,796
Change	+106,966	+21,562	+128,528
% Change	6.5	15.4	7.2

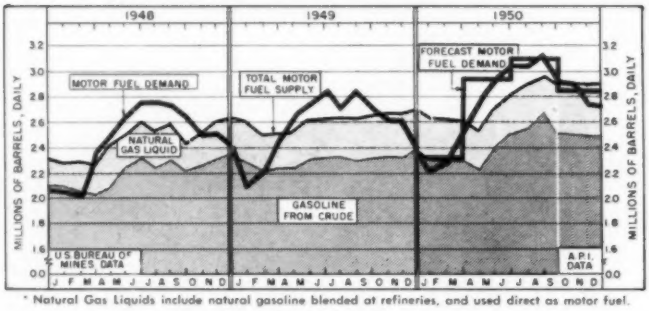
* November from API data.

BM Forecast of Runs to Stills, 1951
(1000 b/d avg., by Quarters)
1st Q., 6,109; 2d Q., 6,139; 3d Q., 6,159; 4th Q., 6,210

Yields on Crude Runs to Stills

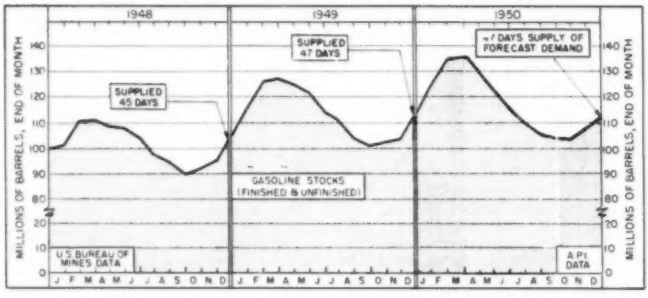
	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Dec. '50 API	42.4	5.7	21.0	20.5
Nov. '50 API	41.9	5.5	19.9	29.2
Oct. '50 BM	41.9	5.4	19.8	20.3
Dec. '49 BM	43.4	6.3	18.6	21.7

Fig. 2, Motor Fuel Demand Continues Strong



* Natural Gas Liquids include natural gasoline blended at refineries, and used direct as motor fuel.

Fig. 3, Gasoline Stocks Close to 1949 Level


1948
1949
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SUPPLIED 45 DAYS
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47 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, END OF MONTH
J F M A M J J A S O N D

Fig. 4, Heating Oil Demand Soars in December

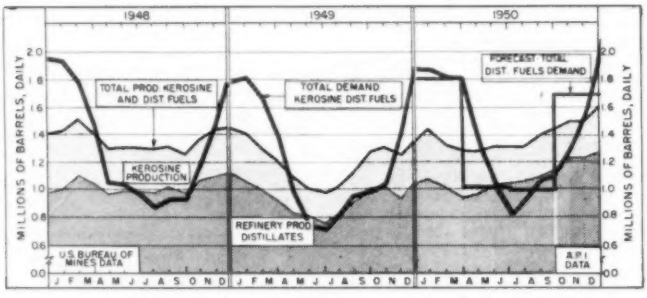
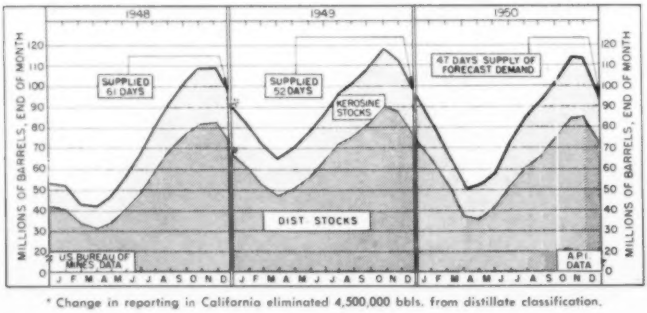


Fig. 5, Heavy Drafts on Heating Oil Stocks in East



* Change in reporting in California eliminated 4,500,000 bbls. from distillate classification.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Dec. '50 API*	2,555	355	2,910
Dec. '49 BM	2,396	298	2,694
Change	+159	+57	+216
% Change	6.6	19.1	8.0

* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '50*	822,917	110,334	933,251
11 Mos. '49	779,308	98,968	878,276
Change	+43,609	+11,366	+54,975
% Change	5.6	11.5	6.3

* November from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Dec. '50 API*	2,735
Dec. '49 BM	2,495
Change	+240
% Change	9.6

* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mo. '50*	933,847
11 Mo. '49	875,022
Change	+58,825
% Change	6.7

* November from API data.

BM Forecast of Motor Fuel Demand, 1951
(1000 bbl. avg., by Quarters)
1st Q., 2,620; 2nd Q., 3,187; 3rd Q., 3,272; 4th Q., 3,043

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Dec. '50 API*	112,631
Nov. '50 API	108,630
Oct. '50 BM	105,764
Dec. '49 BM	111,521

* On Dec. 23

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Dec. '50 API*	349	1,289	1,609
Dec. '49 BM	342	1,032	1,379
Change	+7	+228	+221
% Change	2.0	22.1	16.0

* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mo. '50 API*	107,226	357,192	464,418
11 Mo. '49 BM	91,397	307,530	398,927
Change	+15,829	+49,662	+65,491
% Change	17.3	16.1	16.4

* November from API data.

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Dec. '50 API*	569	1,785	2,345
Dec. '49 BM	488	1,461	1,949
Change	+72	+324	+396
% Change	14.7	22.2	20.3

* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mo. '50*	101,987	356,767	452,754
11 Mo. '49	90,025	294,929	384,954
Change	+11,962	+55,838	+67,800
% Change	13.3	19.9	17.6

* November from API data.

BM Forecast of Heating Oils Demand, 1951
(Kerosine and Distillates)
(1000 bbl. avg., by Quarters)
1st Q., 2,620; 2nd Q., 1,143; 3rd Q., 1,185; 4th Q., 1,837

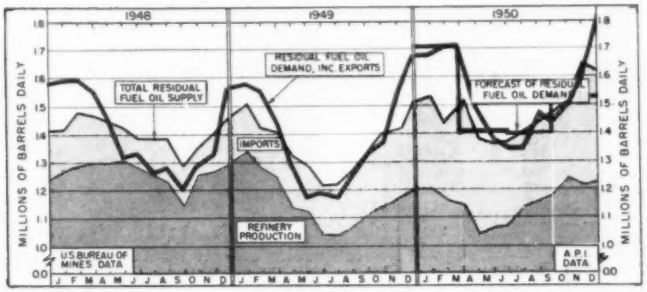
Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Dec. '50 API*	21,819	73,273	95,092
Nov. '50 API	26,861	85,428	112,289
Oct. '50 BM	28,292	85,643	113,935
Dec. '49 BM	20,888	75,207	96,095

* On Dec. 23

Fig. 6, Strong Seasonal Demand for Residual Fuel



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Dec. '50 API*	1,230	395	1,625
Dec. '49 BM	1,206	324	1,527
Change	+27	+71	+98
% Change	2.2	21.9	6.4

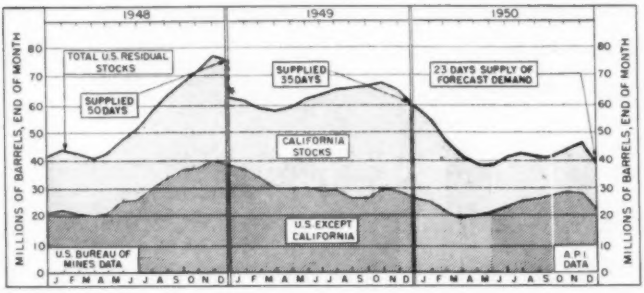
* Through Dec. 23

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mo. '50*	384,346	107,319	491,665
11 Mo. '49	387,546	64,500	452,046
Change	−3,200	+42,819	+39,619
% Change	0.8	66.4	8.7

* November from API data.

Fig. 7, "Resid" Stocks Dip Below 40,000,000 Bbls.



* Change in reporting in California eliminated 13,000,000 bbls. from residual classification.

Residual Fuels Demand

Daily Average (1000 bbls.)

Dec. '50 API*	1,860
Dec. '49 BM	1,553
Change	+307
% Change	19.7

* Through Dec. 23

Total Demand (1000 bbls.)

11 Mo. '50*	510,736
11 Mo. '49	455,377
Change	+55,359
% Change	12.2

* November from API data.

BM Forecast of Residual Fuels Demand, 1951
(1000 b/d avg., by Quarters)
1st Q., 1,722; 2nd Q., 1,437; 3rd Q., 1,467; 4th Q., 1,641

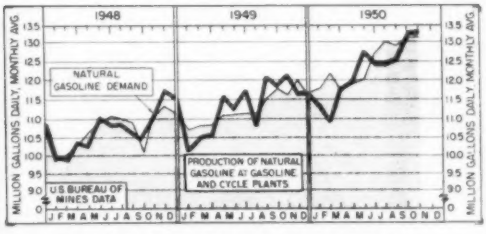
Residual Fuels Stocks

1000 bbls. end of month

	U.S. Except California	Total U.S.
Dec. '50 API*	27,159	39,914
Nov. '50 API	28,632	45,470
Oct. '50 BM	28,845	44,586
Dec. '49 BM	26,204	60,195

* On Dec. 23

Fig. 8, Production and Demand of Natural Gas Liquids


1948
1949
1950
MILLION GALLONS DAILY, MONTHLY AVG.
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D

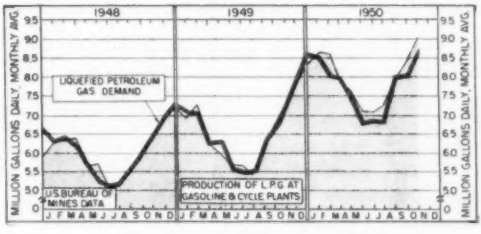
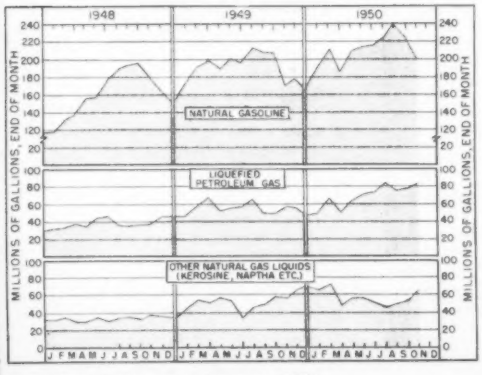

1948
1949
1950
MILLION GALLONS DAILY, MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF L.P.G. AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D

Fig. 9, Stocks of Natural Gas Liquids


1948
1949
1950
MILLIONS OF GALLONS, END OF MONTH
NATURAL GASOLINE
LIQUEFIED PETROLEUM GAS
OTHER NATURAL GAS LIQUIDS (KEROSINE, NAPTHA ETC.)
J F M A M J J A S O N D

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Production (1000 gal./day avg.) Natural Gasoline	LPG**	TOTAL	Demand* (1000 gal./day avg.) Natural Gasoline	LPG	TOTAL
Oct. '50	13,280	9,032	22,312	13,437	8,875	22,310
Oct. '49	11,628	7,252	18,880	12,256	7,193	19,449
Change	+1,652	+1,780	+3,432	+1,181	+1,680	+2,861
% Change	14.2	24.5	17.9	9.6	23.3	14.7
	Total Production (1000 gal.)			Total Demand (1000 gal.)		
10 Mo. '50	3,794,891	2,424,086	6,218,977	3,758,225	2,378,350	6,136,575
10 Mo. '49	3,416,762	1,929,335	5,346,097	3,450,815	1,927,998	5,378,813
Change	+378,129	+494,751	+872,880	+307,410	+450,352	+757,762
% Change	11.7	25.6	16.3	8.9	23.4	14.1

Stocks, End of Month (1000 gal.)

	By Type of Product: Natural Gasoline	LPG	Other Products†	By Location: Refineries	Gasoline Plants	TOTAL
Oct. '50	200,979	81,675	62,837	160,506	244,985	345,491
Sept. '50	224,917	79,599	56,674	112,792	247,998	360,390
Oct. '49	173,483	57,351	59,948	87,864	202,918	290,782

* Demand, including exports but not transfers, is supplied from receipts from outside sources as well as current production and stock changes at gasoline plants. Outside receipts in October totaled 6,214,000 gals.

** Does not include LPG produced at refineries which in October totaled 109,662,000 gals.

† Includes, naphtha, kerosine, specialty and other products.

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The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(E) BADGER & SONS CO., E. B. 46, 47

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(G) CHICAGO BRIDGE & IRON CO. 18

(H) CHIKSAN CO. 16

(I) CRANE CO., THE 17

(J) DU PONT DE NEMOURS & CO., INC., E. I. 2

(K) ELECTRIC AUTO-LITE CO., THE 60

(L) FLUOR CORP., LTD., THE 88

(M) FOSTER WHEELER CORP. ..... Facing 16, 17

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(AS) WYATT METAL & BOILER WORKS .....Outside Back Cover

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FOR ADVERTISED PRODUCT INFORMATION:
Check the Advertiser's Index for advertisement's code letter. Then circle the corresponding code letter on the card below.

FOR "WHAT'S NEW" PRODUCT INFORMATION:
Circle the code number on the card below which corresponds to the number listed at the end of that specific "What's New" item.

THEN:
Fill in your name, position, company and mailing address. Mail the card . . . no postage is required.

MAIL THIS CARD TODAY NO POSTAGE REQUIRED

Issue of JANUARY, 1951

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33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64

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Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV
AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
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AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV
AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB

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WHAT'S NEW!

Equipment
Materials
Processes
Literature

Reviewed by ***WILLIAM C. UHL, Equipment Editor***

TOPS in 'WHAT'S NEW'—1950

Note: Items 1-14 in this month's "What's New!" section will be found on pages 32-33 of this issue. They are repeat reviews of the equipment, products, and literature most interesting to PETROLEUM PROCESSING's readers during the year just past. As a service to those readers who may have missed them the first time they were published, or who may now find them of value in their daily work, these items have been reviewed again this month and are assigned code numbers which can be used on the Reply Cards facing this page.

More Rapid Reset Rate, Rate Action, Provided in New Controller Design

A new force-balance, non-indicating controller for pneumatic transmission systems has a circuit which is said to permit four times faster reset rate and four times faster rate action (Pre-Act) than conventional instruments. The composite effect of the three responses allows start-up and pneumatic setting with no overpeaking. The faster response settings allow the use of rate and reset response, with stability, on processes where these effects were needed but could not be used. This new "Transet Tri-Act" controller incorporates the basic responses of conventional controllers but in a different manner to give improved performance. The circuit contains two closed loops in series—the first containing fixed proportional response and adjustable rate action; the second, with adjustable proportional response and adjustable automatic reset. This arrangement enables the instrument to apply corrective action to the valve soon enough to prevent process conditions from over or undershooting the set point. The new unit supplements the "Transaire" temperate and pressure transmitters and the Miniature (for graphic panels) "Transet" recording receivers, to provide a complete process control system. It can be locally or panel mounted and is for use on temperature, pressure, flow, or liquid level applications. Taylor Instrument Cos.

Circle No. **15** *on Reply Card*

Cost of Low Volume Copying Is Held Down in Model for Small Office Use

A new office copying machine, "BW Copyflex," is claimed to be the lowest cost copying method devised for producing one to 100 copies in an average office. Cost of an 8½ x 11-in. size copy averages under 2c including labor, materials, machine depreciation, and all other charges. All phases of the process occur inside the machine. It needs no inks, tray developing dark rooms, or special lighting. It has no annoying fumes, and does not require any "make ready", plumbing, or exhaust fans. No stencil, negatives, or special training are required. The unit copies any size of original matter up to 11½ in. wide by any length. It can be placed anywhere in an office and requires no special installation. It operates on 110 volt, 60 cycle, A.C. Dimensions are 29½ in. wide, 28 in. deep, 50 in. high. Charles Bruning Co., Inc.

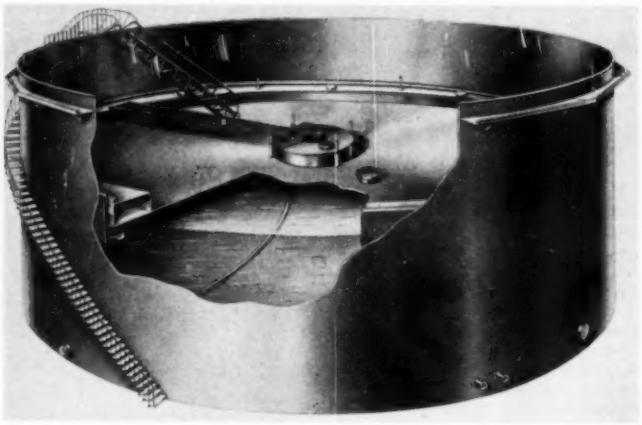
Circle No. **16** *on Reply Card*

Center-Weighted Floating Roof Offers Economic Design for Petroleum Tanks

The new Graver "Center-Weighted" Floating Roof for petroleum storage tanks was developed to combine the vapor-saving and corrosion-resistant characteristics of the double-deck floating roof with the more economical aspects of the conventional pan-type floating roof. The roof is a low-angle, inverted flexible cone which, floating on the top of the petroleum product in the tank, gains stability by the weighted pressure of the cone in the liquid. The turret ir the center is loaded with sand, concrete, or other material as required. Pipe supports are needed only at the center and rim. Effective seal against side walls is maintained by an impervious fabric connecting the roof with a steel shoe actuated by hangers and pushers. Drainage is from the depressed center of the roof through a sump con-

For More Information

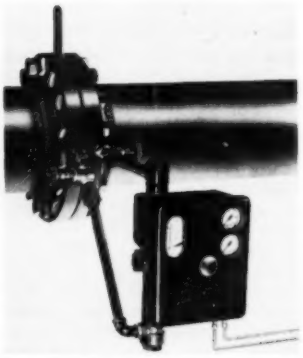
Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



CENTER-WEIGHTED Floating Roof for oil tanks by Graver

nected by pipe or hose with the outside of the tank at ground level. The roof floats directly on the liquid, allowing no air space, thus preventing loss of volatiles, stopping corrosion, and preventing contamination. Two types are offered—the Pontoon (illustrated) for the extremes of northern weather, and the Pan-Type for southern climates where rain is the principal weather problem. Pontoon roofs are in diameters of 60 to 160 ft.; Pan roofs in diameters of 30 to 120 ft. Graver Tank & Mfg. Co., Inc.

Circle No. **17** *on Reply Card*



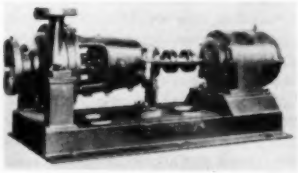
Variable-Area Type Flow Transmitter Uses No Mercury or Diaphragms

The "V/A Cell" is a new flow transmitter developed for differential pressure applications. It is mercury-less but does not utilize a diaphragm. It is basically a through-flow instrument of the variable-area type which measures a by-passed portion of main-line flow. Continuous self-purging is thus provided. A patented magnetic coupling follows float position and converts flow into proportional air for transmission to receiving instruments. The cell is applicable to services on liquid, gas, and vapor streams (including steam), except for slurries, high-viscosity fluids, and some difficult chemical services. All parts in contact with fluid are of Type 316 stainless steel. Total differential range is 50 to 1400 in. of water. Maximum operating temperature is 350° F. The unit may be located in any vertical position relative to the orifice flange. Flow ranges are 5-1 at 50 in. water, 6-1 at 100 in., 9-1 at 150 in., and 10-1 at 200 in. and evr. Fischer & Porter Co.

Circle No. **18** *on Reply Card*

Process Centrifugal Pumps Designed For Hydrocarbons up to 800° F.

The "Type Q" process centrifugal pumps have been especially designed for use with "Dowtherm," hot oil, condensate, propane, butane, gasoline, chemicals, and other liquids at temperatures up to 800° F. Twelve sizes are included, with capacities ranging from 10 to 1000 gpm. at heads up to 325 ft. The pumps are built for minimum NPSH requirements and are available with open, semi-open, or enclosed impellers. Standard models include: bronze fitted, all iron, all bronze, steel, and stainless steel. Special materials can be furnished on order. Casing is split vertically with centerline support to maintain alignment at all temperatures. Bearing housing and stuffing box are water-jacketed. Dismantling can be accomplished without disturbing piping or alignment. Economy Pumps, Inc.



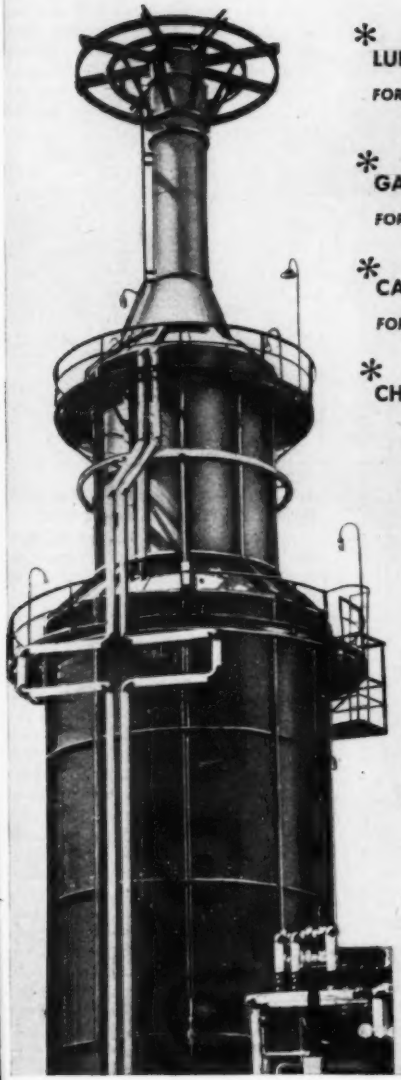
Circle No. **19** *on Reply Card*

Foam Fire Hose Nozzle Can Switch From Spray to Long Stream Instantly

The new "Aer-O-Foam Spray-Stream Nozzle" provides the fire fighter with a means for instantaneous change from a closely-knit foam spray to a long-range foam stream, so that he can combat a serious spill fire or a distant hazard. For example, should heat become too intense when he is using the straight stream, he can switch at once to the protective curtain of the spray. The new nozzle can be used with either pre-mix or a pick-up tube. National Foam System, Inc.

Circle No. **20** *on Reply Card*

THERE'S A PETRO-CHEM ISO-FLOW FURNACE FOR EVERY CAPACITY, SERVICE AND DUTY



* **LUBE OIL PLANT HEATERS**

FOR Crude Distillation • Vacuum Distillation • Solution Rerunning
Raffinate Extraction • Asphalt and Deasphalting
Filtrol Distillation • Contact Clay Treating

* **GAS AND GASOLINE PLANT HEATERS**

FOR Gas Dehydration and Reactivation • Reboiling
Heat Medium Circulating • Rich Oil • Diethylene Glycol

* **CATALYTIC PLANT HEATERS**

FOR Light and Heavy Gas Oil Heating
Atmospheric and Vacuum Feed Preparation • Reforming

* **CHEMICAL PLANT HEATERS**

FOR Gas Cracking • Gas Synthesis
High Temperature Superheating • Steam and Air

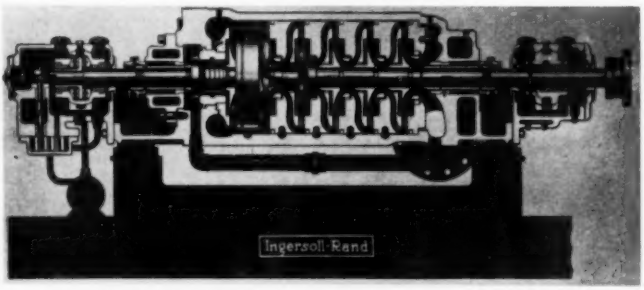
* **FROM 1 TO 70 MILLION BTU'S WITH EFFICIENCIES UP TO 85%**

YOU NAME YOUR PROCESS CONDITIONS and we'll tell you where there is a Petro-Chem Iso-Flow Furnace operating to meet your requirements . . . of the many hundreds now in successful operation, most Petro-Chem Iso-Flow* Furnaces operate beyond their design ratings.*

PETRO CHEM
ISO-FLOW FURNACES
UNLIMITED IN SIZE CAPACITY DUTY

PETRO-CHEM DEVELOPMENT CO., INCORPORATED
120 EAST 41ST STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston - Flagg, Brackett & Durgin, Boston - D. D. Foster, Pittsburgh - Faville Levally, Chicago - Lester Oberholz, California

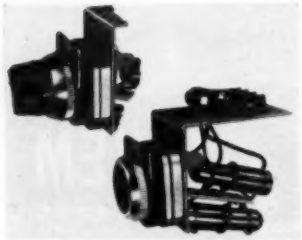


MULTI-STAGE CENTRIFUGAL pump by Ingersoll-Rand

Multi-Stage Pumps Have Capacities to 1600 gpm., Pressures to 1200 psi.

A line of new multi-stage centrifugal pumps for high pressure service to 1200 psi. and with capacities to 1600 gpm. is said to offer efficiency and ease of maintenance in such applications as refinery, pipe-line, and boiler feed pumping. A feature of the new design is a cylindrical bore, horizontally-split casing and a Unit-Type rotor assembly, which is removed easily or installed in the casing with no mating ring fit or alignment problems. The rotor assembly is composed of shaft, impellers, and channel rings. The ring sections contain the multiple volutes and fluid passages as well as the renewable wearing parts for each stage. Known as Class HMTA, the pumps are built in 3-, 4-, 5-, and 6-in. sizes with from 3 to 9 stages. Pressure differential between stages is sealed by cast iron or alloy steel piston rings around the outer diameter of the channel rings. These hydraulic-type, step-seal rings have a metal-to-metal fit with the casing. Ingersoll-Rand Co.

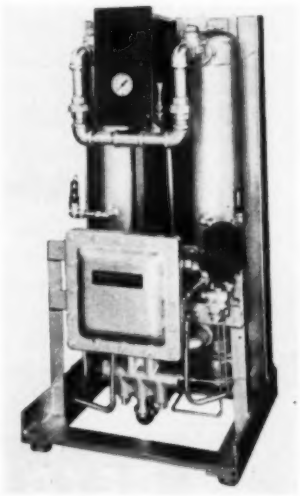
Circle No. **21** *on Reply Card*



Safe Mercury Switch Available in Push Button or Selector Knob Type

A mercury switch with either push button or selector knob has been developed for safe operation in hazardous, explosive locations. The unit consists of a hermetically sealed mercury switch mounted on a lever-operated armature. There is no possibility of any spark because the actuating linkage is purely mechanical in nature. The switch is designed for vertical panel mounting and is a single pole, with either double or single throw action. Push button models have a spring which returns the switch to original position when finger pressure is released. Panalarm Product, Inc.

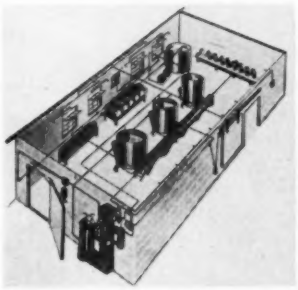
Circle No. **22** *on Reply Card*



50 SCFM Instrument Air Drier Is Offered in Explosion Proof Design

An instrument air drying unit with a capacity of 50 SCFM, air at 100 psig. and 70° F., is being offered in an explosion proof construction meeting the requirements for Class 1 Group D hazards. Operation is fully automatic. Unit comprises two drying chambers filled with Socony-Vacuum Sovabead desiccant. Each chamber is on stream for six hrs. while the other is being reactivated. A timer energizes a solenoid pilot, which switches air flow from one chamber to the other. The timer also actuates the heating element in the chamber to be reactivated. Approximately 2 SCFM of air is purged through to remove moisture. Heating is on for 3½ hrs. The chamber then cools by radiation for the remaining 2½ hrs. in the cycle. Heating elements are operated by 110 volt, 60 cycle A.C. KW input is 1/hr. during heating cycle. Pressure drop through the unit is 3 psig. Outlet dew point is −40° F. Air connections are 1-in. male S.P.T.; conduit is ½-in.; and drain is ¼-in. Industrol Corp.

Circle No. **23** *on Reply Card*

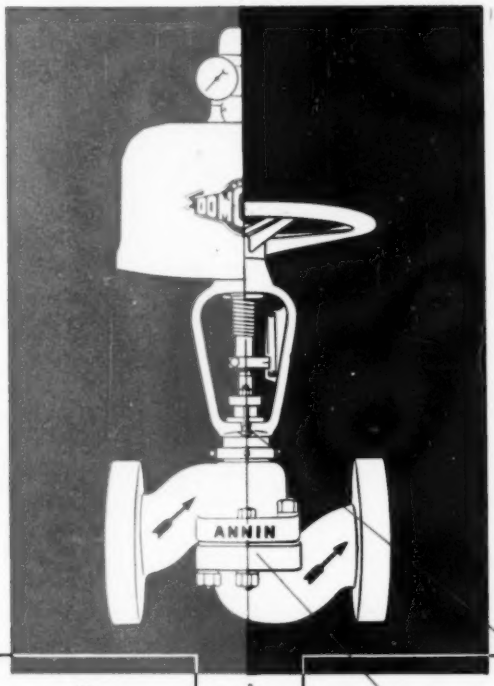


Automatic Dry Chemical System Will Extinguish Flammable Liquid Fires

An automatic fire protection system has been developed to use dry chemical in a piped system. It is recommended particularly for flammable fluid hazards such as: pumping stations, storage rooms, mixing rooms, dip tanks and spray booths, diesel and gasoline engines; and also loose textile stocks, printing presses, and the like. It is operated by an H.A.D. (heat-actuated device) mechanism. When fire starts and temperature increases, air expands within the H.A.D. This trips a nitrogen cylinder release, pressurizing the dry chemical container. Chemical then is discharged through properly located distribution heads into the fire area. Automatic controls can be added to the system to close doors, windows, ventilation ducts, and to operate valves on lines carrying flammable materials. Electric controls can be included to shut off motors, fans, pumps, and sound or transmit signals. Manual operation as well as automatic is provided in all installations. Ansul Chemical Co.

Circle No. **24** *on Reply Card*

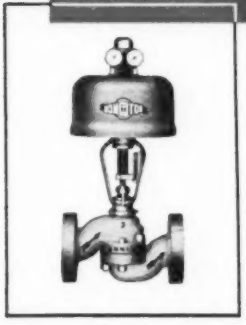
NOW YOU CAN HAVE
Valve Flexibility
IN REFINERY SERVICE



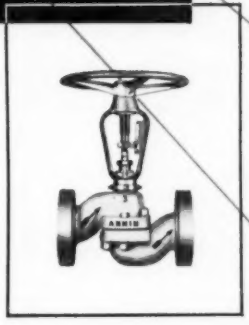
Single-seated for precise automatic or manual control of hard-to-handle fluids. Completely interchangeable. Low maintenance cost.

Annin Domotor and Handwheel Valves are companion valves that permit great flexibility in operation. One may be converted into the other in a matter of minutes. This together with the various characterized valve trims offered, not only permits flexibility in application but reduces your inventory of valves and parts. Maintenance costs are also reduced since almost all servicing can be done without removing the valve from the line.

- PRESSURES TO 3000 PSI
- TEMPERATURES TO 1000°F
- SIZES ¾" TO 4"
- AVAILABLE IN WIDE RANGE OF ALLOYS
- QUICK CHANGE VALVE SEAT
- 50% WEIGHT REDUCTION



DOMOTOR—*For Automatic Control*
Sealed piston in dome actuated by internally controlled differential pressures insures powerful stable valve action. Built-in null type positioner unit. Supply and instrument pressure gages. Light weight—Economical.



HANDWHEEL—*For Manual Control*
Valuable companion valve to Domotor. Ideal for batch and non-continuous fluid processing control. Operates over same range as Domotor. Valve trims interchangeable.

CHOICE OF CHARACTERIZED FLOW

QUICK OPENING PLUG — LINEAR PLUG — PERCENTAGE PLUG

It's a quick and simple matter to change the flow characteristics in Annin Domotor and Hand Operated Valves. Body separates at seat for on-the-job replacement.

CHOICE OF SEATS

HARDFACED — TEFLON

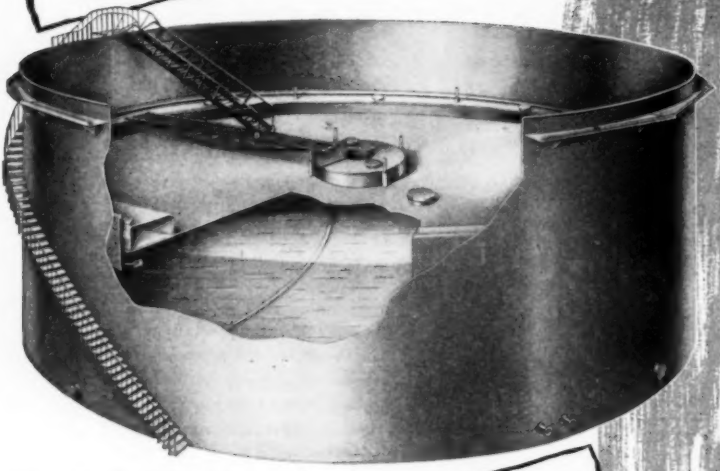
Increased flexibility is yours since you can have a composition or metal seal to meet any fluid condition. Easy to replace. No grinding-in operations necessary.

It will pay you to investigate Annin Valves.

THE ANNIN COMPANY
3500 Union Pacific Avenue, Los Angeles 23, California

[To obtain more data on advertised products see page 80]

NOW . . .



1951 . . . *Graver Center-Weighted Floating Roof Tanks*

AS THEN . . .

Graver's East Chicago shops, 1888

GRAVER

OFFERS THE LATEST DEVELOPMENTS IN VAPOR-SAVING TANKAGE

Graver was almost a half-century old when the Lucas Gusher was brought in and the Spindletop field discovered. As Graver had grown with the petroleum industry since the days of Titusville and Col. Drake, the company was at once ready with a generation of experience to meet tankage requirements in the new Southwestern fields.

Today—on the Golden Anniversary of Spindletop—Graver leads again, offering to oil producers, refiners and marketers its latest development . . . the Graver Center-Weighted Pontoon and Pan-Type Floating Roofs. Write for new book.

1901
Spindletop

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

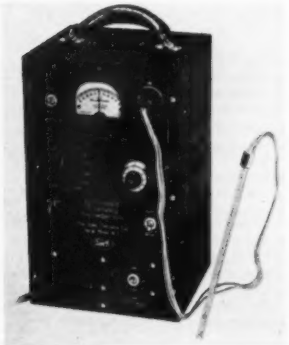
EAST CHICAGO, INDIANA

NEW YORK · PHILADELPHIA · CHICAGO · DETROIT
CINCINNATI · CATASAUQUA, PA. · HOUSTON · SAND SPRINGS, OKLA.

Tedious Laboratory Jobs Are Eased By Foam Rubber Cushion for Stools

Laboratory technicians can now literally "sit on air." A new foam rubber cushion for adjustable-level laboratory stools provides a resilient, non-matting, "breathing" seat over an inch thick, which is said to greatly relieve the strain of prolonged work at analytical balances or other instruments. It will fit the usual steel revolving stool or any stool of 12½ to 13 in. diameter. The foam rubber is covered with Koroseal to provide a chemical-resistant, long-wearing surface. Cushion is held to stool by a self-adjusting band. Grommets around the Koroseal edge provide breathing holes for the foam rubber. Fisher Scientific Co.

Circle No. **25** *on Reply Card*



Electronic Resistance Thermometer Is Accurate and Has Range to 1000° C.

An electronic resistance type thermometer, complete with bridge and bulb, is claimed to be less expensive than non-electronic resistance thermometer equipment. It measures temperatures to 1000° C. with an accuracy of 0.1 and a sensitivity of 0.01° C. Rapid response is said to be obtained by the resistance bulb, on which patents are now pending. The bulb has a tungsten coil sealed in solid pyrex glass or molybdenum in solid quartz. Emil Greiner Co.

Circle No. **26** *on Reply Card*

Multiple Dictation System Simplifies Business Office Correspondence Jobs

A new approach to handling business correspondence has been developed in a system of "remote control" dictation. Called "Televoice," it consists of from one to twenty modified telephones directly connected to a central recording instrument located near the secretary or stenographer. The recording instrument, "Televoicewriter," records the dictation received on plastic discs. Transcription is accomplished with a standard Edison Disc Secretarial Unit. The phone extensions can be located any distance from the recorder. Each extension station gives the dictator a means for listening back to what he has said and a facility for recording corrections. The secretary at the central station takes care of changing the discs and the index slips. Provision is made for eliminating conflict between possible simultaneous dictation. Thomas A. Edison, Inc.

Circle No. **27** *on Reply Card*

Trade Literature

Fractionating Tower Trays

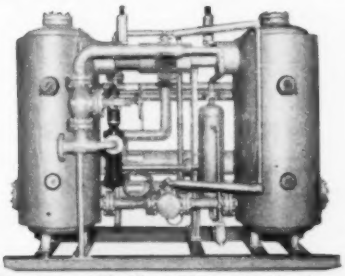
Glitsch Truss-Type Bubble Trays, Bulletin No. 150; 24 pages of engineering information, drawings, photographs on fractionation column internals, their design, fabrication, and installation. Fritz W. Gritsch & Sons, Inc.

Circle No. **28** *on Reply Card*

Air Pollution Control

Catalytic Combustion of Hydrocarbon Vapors; a reprint of an article from *Industrial Heating* describing a patented catalytic type material which can be used in industrial waste gas exhaust stacks to eliminate or greatly reduce noxious and poisonous fumes. Catalytic Combustion Corp.

Circle No. **29** *on Reply Card*



Install the New Pritchard HYDRYER*...

...for Dependable Dehydration of Air and other Gases

Unexcelled for efficiency in drying air for instrument and process controls. Pritchard HYDRYERS are standard packaged units designed to reduce dew points of compressed air and other gases to minus (—) 40° F. Only service connections are required. Specially designed HYDRYER* units can be built to your requirements.

Write for FREE Bulletin No. 16.0.050 *Registered Trade Name

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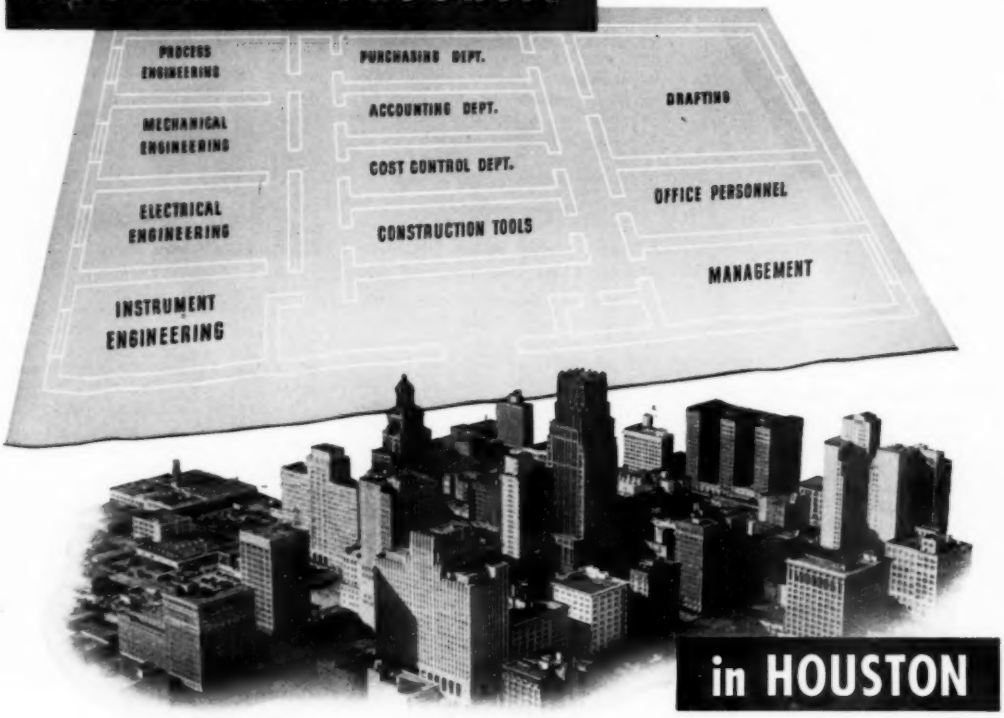

A complete organization for the design, engineering and construction of facilities for the Mid-Continent gas-gasoline industry!

To insure construction costs and engineering practices in keeping with current trends and to better serve the rapidly expanding Mid-Continent gas-gasoline industry, The Fluor Corporation, Ltd., established a Gas-Gasoline Division at Houston, Texas, in 1948. Manned by personnel with extensive gas-gasoline experience, this strategically located division is an organization within itself. A complete service is offered–from preliminary technical and economic studies to the design, engineering and construction of gas-treating plants, compressor stations, gasoline plants, and other facilities related to the industry.

With large storage and maintenance facilities for construction tools and equipment in Paola, Kansas, and with recourse to engineering and research talent of the entire Fluor organization, this highly efficient group combines the operational economy of a small firm with the facilities, know-how and financial security of a major company–one with national recognition and over a half century of experience.

Fluor's Houston "Box Score" since 1948

- Gasoline Plant at Beaver City, Texas
- Gasoline Plant at Pickton, Texas
- Compressor Station at Gilbert, West Virginia
- Dehydration Plant at Anahuac, Texas
- Gasoline Plant at Provident City, Texas
- Compressor Plant addition at Golden Meadows, Louisiana
- Compressor Station addition at Tomball, Texas
- Dehydration Plant at Kopperston, West Virginia
- Hydrogen Sulfide Removal Plant at Corpus Christi, Texas
- Compressor Station at Charleston, West Virginia
- Chemical Specialties Plant near Houston, Texas
- Compressor Station Piping at Mt. Sterling, Kentucky
- Compressor Station addition at Philadelphia, Pennsylvania
- Gasoline and Treating Plant near Snyder, Texas

FLUOR

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DESIGNERS AND CONSTRUCTORS of Refining, Natural Gas and Chemical Processing Plants.
MANUFACTURERS of Mufflers, Pulsation Dampeners, Gas Cleaners, Cooling Towers and Fin-Fan Units.

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif. Offices in principal cities in the U.S.A.
REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic St., London, E.C.I., England

Giant Lube Oil Plant

New Horizons, Lummus at Cit-Con; a 24-page pictorial brochure giving a refinery tour in pictures of the Cit-Con Oil Corp.'s new lube oil refinery at Lake Charles, La. The Lummus Co.

Circle No. **30** *on Reply Card*

Metal Inspection Method

Dy-Chek, the Dye Penetrant Inspection Method, Bulletin 500; shows how this new technique of non-destructive testing of metal and weldments is used in various fields. Dy Chek Co. Div. of Northrop Aircraft Inc.

Circle No. **31** *on Reply Card*

Process Instrumentation

Instrumentation, Vol. 5, No. 1; contains articles on instrument problems as solved by Shell Chemical, instrumentation of equipment for natural gas dehydration, and on the maintenance and repair of diaphragm motor valves. Brown Instrument Div., Minneapolis-Honeywell Regulator Co.

Circle No. **32** *on Reply Card*

Locknut Fasteners

Types of Locknuts and Their Principles of Operation; an 18-page booklet describing in detail, with photographs, cutaway views, and drawings, the various designs in locknuts and listing their manufacturers. Locknut Section, Industrial Fasteners Institute.

Circle No. **33** *on Reply Card*

Corrosion-Resistant Valves

Pacific Corrosion Resistant Valves, Sales Bulletin SS100; an 18-page booklet covering 150 and 600 lb. gate, globe, and swing and check valves; including a table of the resistance of four popular alloys to over 150 common corrosives, and an article on the fundamentals of corrosion. Pacific Valves, Inc.

Circle No. **34** *on Reply Card*

Corrosion-Resistant Coating

Carbo-Kote 6020, New Product Data Sheet C-42; lists uses, chemical and physical specifications, methods of application, prices, etc. for a brush-on tank lining and floor surfacing for many acids, alkalis, and solvents. Carboline Co.

Circle No. **35** *on Reply Card*

Testing Instruments

R.S. and AC-ME Testing Instruments, Bulletin 50; a 32-page catalog on equipment for natural gasoline plant or refinery laboratories; including recording and controlling gravitometers, gravity balances, dew point testers, compressibility apparatus, charcoal distillation apparatus, dead weight testers, LPG test equipment, RVP bombs, calorimeters, and the like. The Refinery Supply Co.

Circle No. **36** *on Reply Card*

Piping Manufacture

One Hundred Years of Piping Progress, 30-page booklet delineating the history of Grinnell, 1850 to 1950, describing its operations today, and typical products—ranging from cast and malleable iron fittings to prefabricated piping, special hangers and supports, valves, and fire protection specialties. Grinnell Corp.

Circle No. **37** *on Reply Card*

Processing Equipment

Powerfax, Autumn, 1950; includes a five-page article describing Elliott equipment in Lion Oil Co.'s refining and chemical plants, such as blowers, steam turbines, condensers, heat exchangers, barometric condenser, two-stage and three-stage steam jet ejector, etc. Elliott Co.

Circle No. **38** *on Reply Card*

Electronic Process Control

"Telemaster", Bulletin No. 1100; eight pages of complete information on a new electronic master control system for both automatic and manual control of processes, which combines the null-balance principle of detection with electronic transmission to form a rapidly responsive system that is fast in completing adjustments, regardless of distances involved. Republic Flow Meters Co.

Circle No. **39** *on Reply Card*

Polarographic Analysis

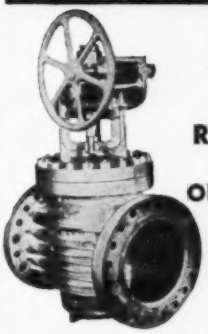
Electro-Chemograph Type E for Polarographic Analysis, Catalog EM9-90(1); 16 pages of technical information on polarographic equipment adaptable to operation from standard 115 volt AC, and describing the applications and the theory of its principle of operation. Leeds & Northrup Co.

Circle No. **40** *on Reply Card*

High-Speed Electric Motors

Allis-Chalmers Large 2-Pole Squirrel Cage Induction Motors, Bulletin 05B7550; gives construction and technical details on motors built for boiler feed pumps, oil pipeline pumps, centrifugal blowers, etc.; a line of standard 40° C. rise, continuous rated, 2-pole, 60 cycle, 3600 rpm., bracket-bearing motors for direct-connected

WEDGEPLUG
ALL-PURPOSE
STEEL VALVES



LIFTS
TURNS
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IN ONE
OPERATION

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DRY
PLUG
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PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".

Wedgeplug Valve Co., Inc.
Department "P"
New Orleans 15, U.S.A.

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OIL AND GAS
BURNING
EQUIPMENT

- Mechanical Atomizing Oil Burners
- Steam Atomizing Oil Burners
- Refractory Burner and Muffle Blocks
- Industrial Gas Burners
- Low Air Pressure Oil Burners
- Fuel Oil Pump Sets
- Valves, Strainers, Furnace Windows
- Tandem Block Combustion Units
- Combination Gas and Oil Burners

Detailed information gladly sent you upon request.

NATIONAL AIROIL BURNER

NATIONAL AIROIL BURNER COMPANY INC.

1297 Sedgley Ave., Philadelphia 34, Pa.
Southwestern Division: 3513 So. Blvd., Houston 6, Tex.

[*To obtain more data on advertised products see page* 80]

with this New, Improved AIRETOOL Tube Rolling Control

You can save time and cut as many as 8 valuable hours from similar tube rolling jobs with this new AIRETOOL Control. Uncanny tube rolling accuracy is now assured, even with inexperienced operators.

MOBILE UNIT

BETTER these 8 important ways . . .

- The original control calibration is permanent . . . needs no adjustment.
- Relay operation is accurate and free from chatter.
- Employs or needs no delicate electronic tubes.
- No voltage regulator necessary for regular power sources.
- Minimum number of moving parts to wear out.
- Control consumes minimum current . . . delivers maximum power to motor.
- Every Control individually calibrated and shop tested before delivery.
- Designed for field and maintenance shop work as well as for new work. Available as a mobile unit.

BEST in Lab, Shop and Field . . .

Every test proves that the AIRETOOL control is the best obtainable at any price. Cash in on these benefits now. Write the AIRETOOL Manufacturing Co., 336 S. Center St., Springfield, Ohio.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

BRANCH OFFICES: New York, Philadelphia, Chicago, Houston, Tulsa, Baton Rouge

What's New!

drives in all ratings 900 hp. and larger. Allis-Chalmers Mfg. Co.

Circle No. **41** *on Reply Card*

Steam Traps

Anderson Float Traps for Steam and Air Service, Condensed Bulletin No. 950; gives catalog information, capacities, pressures, sizes, and price lists on three principal float traps in the line. V. D. Anderson Co.

Circle No. **42** *on Reply Card*

Steel Pipe Technical Data

B&W TDC 138 gives data on seamless and welded pipe of carbon, alloy, and stainless steels; Table I listing dimensions in 16 sizes of pipe from ⅛ to 8-in. nominal size, with five different weight schedules according to wall thickness and I.D.; Table II giving ASTM and ASME specifications with grades and analyses for various types of pipe for high temperature and other services. Babcock & Wilcox Tube Co.

Circle No. **43** *on Reply Card*

Diesel Engines

Baldwin Series 700 Diesel Engine, Bulletin 320; four pages of specifications, line drawings, and other data on a line of four-cycle engines with 17-in. bore, 2-in. stroke, and speed range of 257 to 375 rpm., with ratings ranging from 710 hp. for 6-cylinder, normally aspirated, to 2080 hp. for 8-cylinder, supercharged models. Baldwin-Lima-Hamilton Corp.

Circle No. **44** *on Reply Card*

High Capacity Chlorinizer

Builders Chlorinizer, Volumetric Model HCVS, Bulletin 840-G27, four pages giving operating principle, features, etc. on a visible flow chlorinizing unit designed to meter accurately at rates from 100 to 6000 lbs./24 hrs. Builders-Providence, Inc.

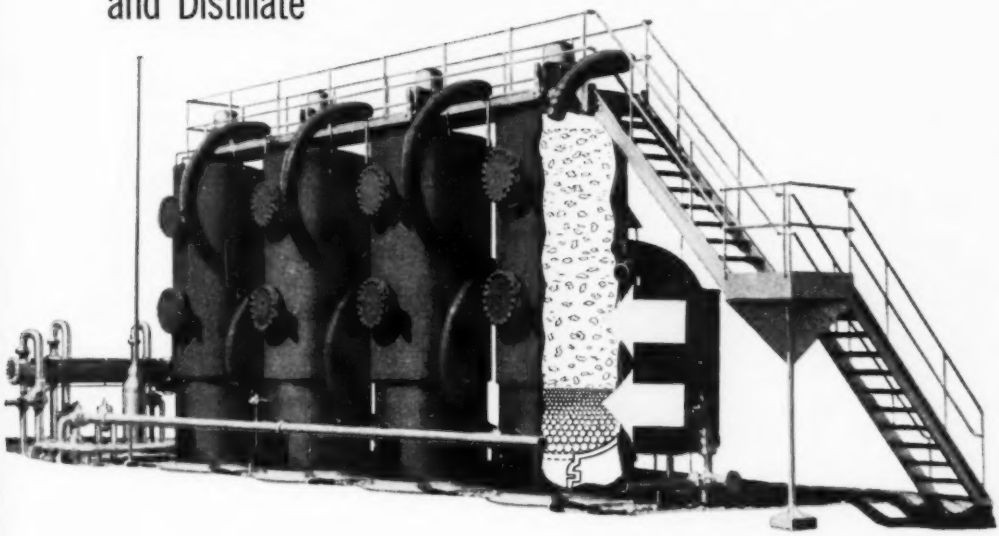
Circle No. **45** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

Wyco Pipe Line Company's **Unique Dehydration Unit** Dries Gasoline and Distillate

The Products Pipe Line Department of the Standard Oil Company (Indiana), one of the principal stockholders of Wyco Pipe Line Company, has recently designed and supervised the construction of a dehydration plant located near Casper, Wyoming, on the Wyco pipe line. Designed for either up or down flow, gasoline and distillate enter the towers through wide radii pipe bends, and are alternately dried at a rate approximating 20,000 barrels per day. ALCOA *Activated* Alumina, supported by ALCOA Tabular Alumina Balls, is the desiccant chosen to readily obtain the desired cycle at 500°F. and 80 lbs. pressure.



with **ALCOA** Activated* Alumina supported by **ALCOA** Tabular Alumina Balls

Not only at Wyco, but throughout the petroleum industry, ALCOA *Activated* Alumina has a reputation as a dependable, economical drying agent. Commercially pure, it is one of the few solid adsorbents that does not change its form or properties. It will not swell, soften or disintegrate, is noncorrosive and practically iron-free.

In addition, bed supports and bed covers of ALCOA Tabular Alumina Balls offer higher efficiency—better operation—of drying towers. These high-purity ceramic balls replace fine mesh inside screens. They reduce resistance to stream flow, and are adaptable to any depth of bed support (five sizes of balls to choose from).

Whatever your drying problem, it will pay you to investigate ALCOA *Activated* Alumina and Tabular Alumina Balls. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 616A Gulf Building, Pittsburgh 19, Pennsylvania.

*Reg. T. M., *Aluminum Co. of America*

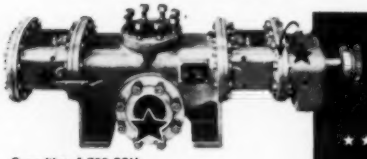
Alcoa Chemicals

ALCOA ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

NEW Sier-Bath SCREW PUMP

for NON-LUBRICATING LIQUIDS



Capacities: 1-700 GPM

Discharge: 1000 PSI for viscous liquids
250 PSI for water

External Gear & Bearing Bracket Type with *New*

★★ "Dual-controlled" ROTORS

★ Single-point ALIGNMENT

USED to move your non-lubricating fluids or semi-fluids, this powerful new screw pump will give you greater dependability, longer life, and cost you less to service and maintain. For less wear on bearings and timing gears, its rotors are "dual-controlled"—*axially* by heavy-duty thrust bearings, and *radially* by precision cut timing gears and heavy duty roller bearings.

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COMING MEETINGS

Discuss Use of Radioisotopes In the Petroleum Industry

"The Use of Radioisotopes in the Petroleum Industry" will be discussed in a paper to be presented at the "Symposium on Radioisotopes" being held Friday, Jan. 19, in the Hotel Statler, New York City.

The one-day symposium is being sponsored by the New York Section of the American Chemical Society, with afternoon and evening sessions. The paper on radioisotopes in the petroleum industry is scheduled for 8:30 p.m., and will be presented by Dr. Paul H. Emmett, senior fellow at Mellon Institute of Industrial Research, Pittsburgh, Pa.

Other papers will cover "Carbon 14 and New Frontiers of Organic Chemistry," "Principles of Radioisotopes Technology," and other phases of the radioisotopes field.

Chairman of the symposium will be Dr. Paul C. Aebersold, chief of the isotopes division of the U. S. Atomic Energy Commission. Arrangements are being handled by John Kotrady, of The Texas Co.

MEETINGS . . . for the Oil Man

JANUARY

15-18, Second Plant Maintenance Conference and Show, Public Auditorium, Cleveland.

19, American Chemical Society, New York Section, Symposium of Radioisotopes, Hotel Statler, New York.

FEBRUARY

23, Natural Gasoline Association of America, Regional Meeting, Settles Hotel, Big Spring, Texas.

MARCH

5-7, Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh.

5-9, American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.

11-14, American Institute of Chemical Engineers, Regional Meeting, The Greenbrier, White Sulphur Springs, W. Va.

12-16, First South American Oil Congress, Montevideo, Uruguay.

13-16, National Association of Corrosion Engineers, Annual Conference and Exhibition, Hotel Statler, New York.

19-23, Conference on Industrial Personnel, Dept. of Industrial Engineering, Columbia University, New York.

19-23, 7th Western Metal Congress and Exposition, American Society for Metals, Civic Auditorium and Exposition Hall, Oakand, Calif.

APRIL

1-5, American Chemical Society, 119th National Meeting (divided), Boston, Mass.

2-4, Western Petroleum Refiners Assn., 29th Annual Meeting, Plaza Hotel, San Antonio, Texas.

8-12, American Chemical Society, 119th National Meeting (divided), Cleveland, Ohio.

16-18, American Society of Lubricating Engineers, National Convention, Bellevue-Stratford Hotel, Philadelphia.

30-May 3, American Petroleum Institute, Division of Refining, Midyear Meeting, Mayo Hotel, Tulsa.

30-May 4, 4th National Materials Handling Exposition, International Amphitheatre, Chicago.

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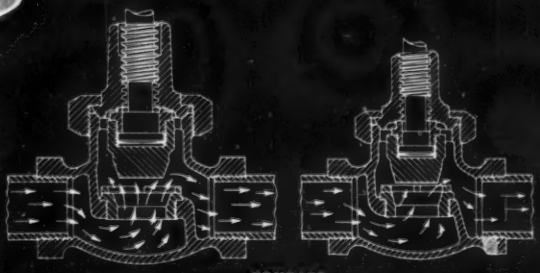

COMPARE
the flow characteristics of the new Powell "W.S." Valve (left) and the ordinary globe valve (right). Note the extra large opening through the seat (nominal pipe size) and the greatly increased lift of disc, when wide open.

This is actually a dual service valve in that it can be throttled to any desired degree, yet, when wide open, permits FULL FLOW through the body. Thus turbulence and pressure drop are reduced to a minimum—a triumph in engineering that exemplifies Powell's continual leadership in the field of industrial valve design.

Powell "W. S."
Bronze Globe Valve
Fig. 2608

Write for folder giving full description of the many advanced engineering features of this valve.

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PERSONALS

William Lyman Stewart, Jr., executive vice president, Union Oil Co., Calif., is the newly elected vice president of the Refining Division, American Petroleum Institute, succeeding Chester F. Smith, vice president, Standard Oil Co. (N. J.).

Mr. Stewart

He attended Stanford University and MIT, graduating from the latter in 1923. He started in with Union Oil Co. as a reseach assistant in 1923, having previously worked for the company as a pipefitter at the Los Angeles refinery during summer vacations. He was made a director of Union in 1927, a vice president in 1930 and executive vice president in 1942.

In addition to his outside activities as a member of the API board of directors, Mr. Stewart is chairman of the Smoke and Fumes Committee of the Western Oil & Gas Assn., which has led the oil companies' campaign in the effort to relieve smog conditions in the Los Angeles area. He is also vice president of the Air Pollution and Smoke Prevention Assn. of America. He is a director of Stanford University and a trustee of California Institute of Technology. Mr. Stewart is a grandson of Lyman Stewart, co-founder of Union Oil Co. of California.

* * *

M. P. L. Love, manager of Shell Oil Co.'s manufacturing-research department in New York, has been appointed manager of Shell's Houston refinery to succeed **P. E. Foster,** who has retired.

Mr. Love will be succeeded by **Dr. D. L. Yabroff** who, for the past 16 years, has been on the staff of Shell Development Co. and has been an associate director of that organization since 1948.

Mr. Love joined Shell in 1927 as a junior chemist in the company's Wood River, Ill. refinery. He resigned the same year to complete his studies at Mississippi College, where he was graduated in 1928 with a B.A. in chemistry. He also did graduate work in organic and industrial chemistry at the University of Virginia.

In 1935 he returned to Shell as a chemist at Wood River. During the next eight years he held several positions of increasing responsibility, including those of chief research chemist and research director at Houston. He became research director at Wood River in 1943 and held that position until moving to New York in 1948 as manager of manufacturing-research.

Mr. Foster joined the company as a loader at the Martinez refinery in 1916. He served as manager of Shell refineries in Arkansas City, Kansas, and Norco, La., before becoming manager of the Houston refinery in 1943.

* * *

Dr. Gustav Egloff, director of research at Universal Oil Products Co., has been elected by the University of Edinburgh's Senatus Academicus to give the biennial "Romanes Lecture in Chemistry for 1951."

* * *

E. R. Baker, manager of Continental Oil Co.'s Central Research Laboratories, has been promoted to assistant manager of the Development and Research department, Ponca City.

Mr. Baker

Mr. Baker, a widely experienced industrial chemist and wartime assistant research chief in chemical warfare, joined Continental in 1948 as manager of the then newly-established Central Research Laboratories.

During World War II he served under the late Brig. Gen. W. C. Kabrich as assistant chief of the Technical Division of Chemical Warfare, now known as the Chemical Corps. On receiving his discharge in 1946 as a Colonel he received the Legion of Merit Award for his work in chemical warfare.

He attended Yale University, received his B.S. degree in chemistry and studied three years in addition at the Yale Graduate School. Afterward he received an LL.D. degree from the Suffolk Law School in Boston and became a member of the Massachusetts bar.

* * *

E. A. Smith has been appointed manager of manufacturing and **V. M. Norwood** general superintendent of the Petrolia refinery of Canadian Oil Co's., Ltd.

Mr. Smith has been associated with Canadian Oil Co's. since 1919, when he joined the company as chief chemist. In 1934 he assumed additional duties as assistant superintendent of the company's refinery at Petrolia. In 1936 he was promoted to superintendent and subsequently became general superintendent, which post he has held up until the present time.

His successor as general superintendent, Mr. Norwood, graduated from the University of Toronto in 1935 and joined the company the following year. In 1941 he was promoted to the post of chief engineer and in 1943 became plant superintendent.

* * *

J. W. Pegg has been named vice president of Shell Development Co., and will be in charge of the New York offices of the company, research affiliate of Shell Oil Co.

Mr. Pegg

Mr. Pegg was born in Kansas City, Mo., and received his L.L.B. from the University of Missouri. Joining Shell in 1937 as an attorney, he progressed rapidly through positions of increasing responsibility in the legal and marketing departments to become, in 1945, executive assistant to the vice president, marketing.

In 1948, Mr. Pegg went to St. Louis as manager of the company's St. Louis marketing division. The following year he became manager of Shell Development's New York office, which position he held until his present appointment.

* * *

Paul E. Kuhl, who has been serving as assistant general manager of East Coast manufacturing for Esso Standard Oil Co., has begun a one-year period as assistant general manager of Esso's over-all manufacturing operations.

The position, a newly-created one, was established as a part of the company's management development program. Present plans provide that the job will be filled on a rotational basis.

Mr. Kuhl has been with Esso Standard since 1926, when he joined the company as a student engineer. After serving with the old development division and the technical service division, he went to Aruba in 1932 as assistant superintendent of the refinery there in charge of the technical department.

Subsequently he was assistant manager and then associate manager of the Standard Oil Development Co.'s process division. He became assistant manager of the Southern East Coast units in 1944, manager in 1945. He moved to New York in March, 1948.

* * *

Dr. Charles W. Beckett has been appointed to the Thermodynamics Section of the National Bureau of Standards where he will be active in the preparation of tables of thermal

properties of gases. This project tabulates various thermodynamic properties of gases which are of importance in the design and operation of wind-tunnels and jet-engines.

Dr. Beckett was a research associate of the API at the University of California from 1945 to 1947, where he did research on properties of hydrocarbons and statistical thermodynamics calculations. He has written several papers dealing primarily with the thermodynamic properties of cyclohexanes for the *Journal of the American Chemical Society* and for the *Journal of Research of the National Bureau of Standards*. From 1948 to 1950, he was associate supervisor of the literature survey group at Ohio State University also dealing with thermodynamics.

He received his B.S. from the University of California in 1943, and his Ph.D. in 1945.

* * *

Dr. Frederick M. Smith has been appointed organic chemist for Deep Rock Oil Corp. Dr. Smith received his B. S. degree from the University of Nevada in 1931, then attended Syracuse University for his master's and doctorate degrees from 1931 to 1937. Beginning in 1937, he taught chemistry at Texas A. and M. College until 1944, when he joined Phillips Petroleum, his last employer.

* * *

Walter Gaylor has joined the staff of The Technical Survey, Newark, N. J., as an assistant editor.

Mr. Gaylor majored in chemistry at Pennsylvania State College, receiving his B.S. in 1935. After graduation, he was employed in the technical laboratories of Tide-Water Oil Co. at the Bayonne refinery. He left Tide-Water to enter the graduate school at Harvard University, receiving an M. A. degree in 1938. After ending five years in the Army Air Forces as a major in the 22nd Bombardment Group, Mr. Gaylor returned to Harvard University to do graduate work towards his doctorate degree. He was an associate professor of English at Illinois College prior to his joining the staff of The Technical Survey.

* * *

P. K. Kuhne, assistant to the general manager, Gulf Oil Corp.'s manufacturing department, has been given the added assignment of assisting in the administration of the technical division, manufacturing department.

This appointment is consistent with the Gulf Policy of promoting from within the organization whenever possible.

Mr. Kuhne received a Bachelor of Science degree in chemistry from Tulane University in 1927. He joined Gulf as an assistant chemist in the Port Arthur refinery in 1927 and subsequently became chief chemist, Philadelphia refinery, in 1930, and supervisor of the refinery technology division there in 1934.

Mr. Kuhne was transferred to the company's general offices in Pittsburgh as assistant to the general manager, manufacturing department, in 1941 and will continue to be located there.

He served on numerous PAW Committees during the war and was a member of the SHAEF sponsored Technical Oil Mission to Germany with the honorary rank of colonel.

* * *

Dr. Robert B. Killingsworth, assistant director, Technical Service Department, Brooklyn, has been transferred to the headquarters staff of Socony-Vacuum Laboratories, a division of Socony-Vacuum Oil Company, Inc., New York.

Dr. Killingsworth is a graduate of the University of South Carolina and holds a doctor of philosophy degree from New York University. He started with Socony-Vacuum as a chemist in 1937.

* * *

Among four new Directors of the American Institute of Chemical Engineers are **Charles R. Nelson,** manager of the process engineering department of the Shell Development Co., Emeryville, Calif.; and **R. C. Gunness,** manager of research of the Standard Oil Co. (Ind.).

Mr. Nelson, a new director, attended Carnegie Institute of Technology and the University of Michigan, receiving a Ph. D. in chemical engineering in 1935. He has worked for the Pittsburgh Steel Co., and the General Chemical Co. and has been with the Shell Development Co. since 1941.

Mr. Gunness is a graduate of Massachusetts State College and Massachusetts Institute of Technology. He served for several years as assistant professor of chemical engineering at the latter institution, and in 1938 went to the Standard Oil Co. as a group leader. He was assistant director of research in 1943, associate director of research, 1945, and in 1947 was promoted to his present position.

* * *

Frank C. Fahnestock, technical advisor since 1948 to the chief engineer, refinery engineering division, of the Socony-Vacuum Oil Co., Inc., has been appointed coordinator of foreign refining in the manufacturing department at New York.

Mr. Fahnestock, graduate of the Massachusetts Institute of Technology in 1931, started with Socony-Vacuum as a student engineer and held various operating jobs at the Paulsboro, N. J., refinery until 1939, when he was transferred to the refinery engineering division. He was the United States member of the Allied Oil Working Party for Western Germany from March to May, 1949, and ECA consultant on oil for Western Germany from March to May of 1950.

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EDITORIAL VIEWPOINTS

Opinions and Comments on Current Topics

Mobilizing to Keep Plants Running

THE extent of manpower allocation called for in the nation's coming mobilization program will throw even greater personnel problems on refinery managers than during World War II. The high degree of national industrial activity to be required, together with the needs of the Armed Services, will make heavy demands on oil company working forces.

The need for keeping refineries and natural gasoline plants operating, to supply vitally needed petroleum products, will be recognized by all authorities. However, as in the last war, the task of making sure that there is sufficient manpower on hand to keep the plants running, and to carry on essential research and other laboratory work, will fall entirely on the oil company executives.

Therefore, it behooves the oil company heads and operating managers to do their own manpower planning without delay, and to determine what reservoirs of workers are available to their individual plants as their present staffs become depleted. A new factor will be involved in attempting to bring back retired workers and older men for the present emergency. More of these men now enjoy pensions, or they are benefitting under the government's Social Security program. Perhaps more than the inducement of being again employed and on the payroll will be needed to secure the services of this class of workers to even the extent they were previously available.

During World War II women workers filled in very acceptably in many plant jobs. Their generally better housekeeping instincts, as compared with men, and their more careful attention to routine detail made them good as laboratory technicians as well as in other capacities where highly technical training and experience were not required. On the other side of the ledger, many industrial activities which were carried on during the last war will eventually be curtailed in the present mobilization. Their workers may become available to the refineries and other essential industries.

Farsighted oil company management will take time now to review their own World War II experience in personnel problems. They will also survey their present staffs to determine where older men now employed may be advanced to fill the places of younger men who will be called into the Armed Services, or whose experience is such they will likely be mustered into outside defense activities. Management will also start to catalog and keep track of reservoirs of possible future workers in their communities, to the end that their mobilization of manpower will be as efficient as possible.

There is Grease, and Grease

WRITING in the October issue of Petroleum Processing, Ralph R. Matthews, lubrication authority, called attention to the need for a new definition for lubricating greases. He pointed out that the ASTM definition of many years' standing specified a combination of a petroleum product and a soap or a mixture of soaps, while actually lubricating greases as now manufactured may be straight petroleum products, oils containing fillers, or even combinations of soaps and synthetic oils. Further, new types of thickeners which are not soaps are now being used with either petroleum or synthetic oils in the manufacture of lubricating greases, particularly for aircraft.

This subject of a new definition for lubricating greases is now in the hands of ASTM's Committee D-2 and revision of the definition in the making. While this step is being taken, attention should also be called to the importance of the oil companies using the correct term to specify their product of this type.

The Technical Committee of the National Lubricating Grease Institute, at the recent annual meeting of the NLGI in Chicago unanimously resolved that, since the word "grease" is a broad term covering everything that looks or feels greasy, including animal and vegetable fats, and that since lubricating grease is a product carefully manufactured to meet strict specifications and for lubricating purposes exclusively, the full term "lubricating grease" should be used in referring to it.

The oil companies should follow this recommendation and also encourage their customers to accept it. Lubricating greases have been proved most effective in many applications and they are entitled to full recognition under the correct nomenclature. The general use of the approved term may help do away with some of the confusion which has existed in the past in the specification and application of this oil industry product.

Inconsistent, to Say the Least

ANOTHER oil company has been asked to do a government chore outside its usual field of activity. Phillips Petroleum Co. has been appointed manager of an Atomic Energy Commission materials testing reactor now being built in the west. At the same time, the efforts of established government agencies such as the Department of Justice and the Federal Trade Commission to discredit the oil companies and bigness in industry in general continue unabated.

If Phillips and other oil companies cannot be trusted in their normal peacetime relations with the public, how can the government justify placing them in positions of high authority in the mobilization program? Fundamentally wrong policies in company management and disregard for the public welfare are potentially more dangerous here than in routine business enterprise.

It must be assumed that the government recognizes that industrial training and experience, as developed through competitive forces and free enterprise, are extremely valuable assets when important new projects are to be undertaken in the defense effort. It seems inconsistent to maintain that the same characteristics do not work to the public's interest in normal business procedures, at least until it is definitely proved otherwise in specific instances.

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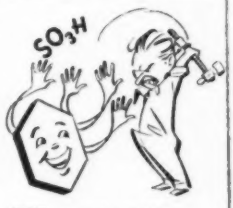
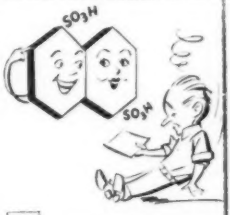
☐ Time-consuming stratification step.

☐ Solvent losses during extractions.

☐ Batches too small.



☐ Organics resist conventional sulfonations.



☐ Wrong isomers formed.

☐ Filtration of sulfate sludge.

☐ Spent acid disposal.

☐ Corrosion from by-product HCl.

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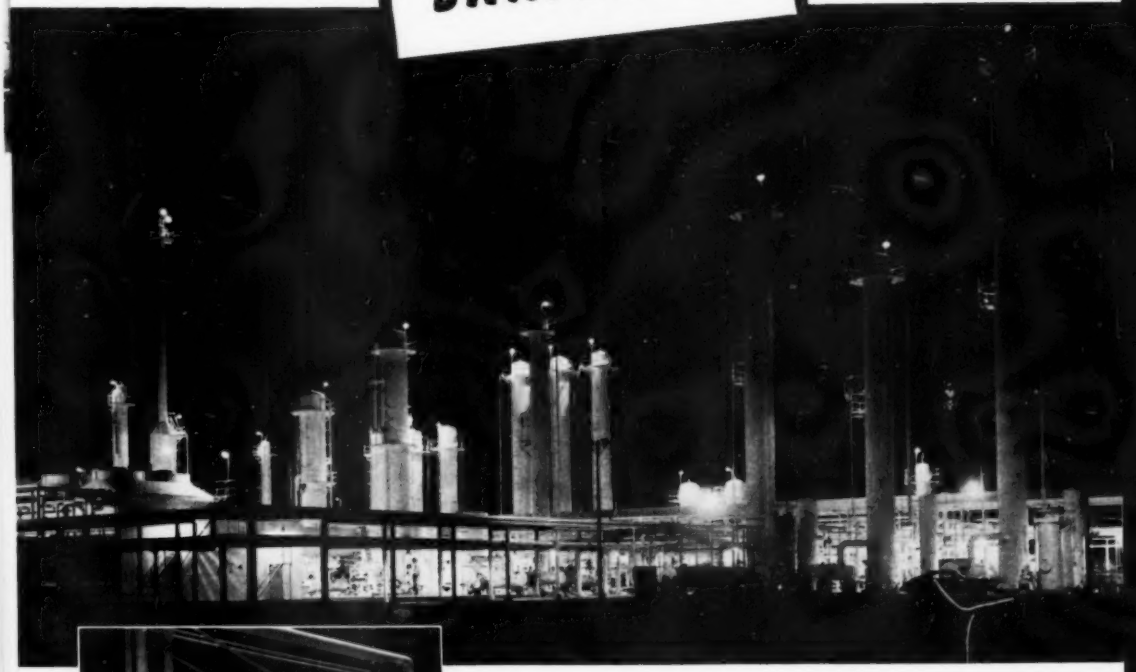

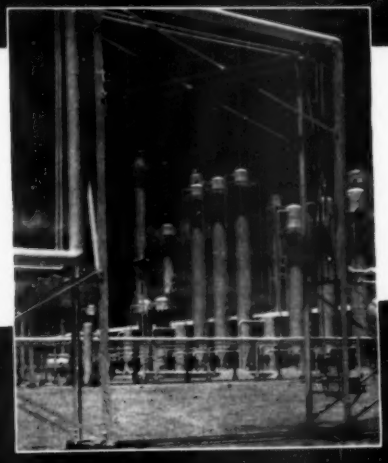

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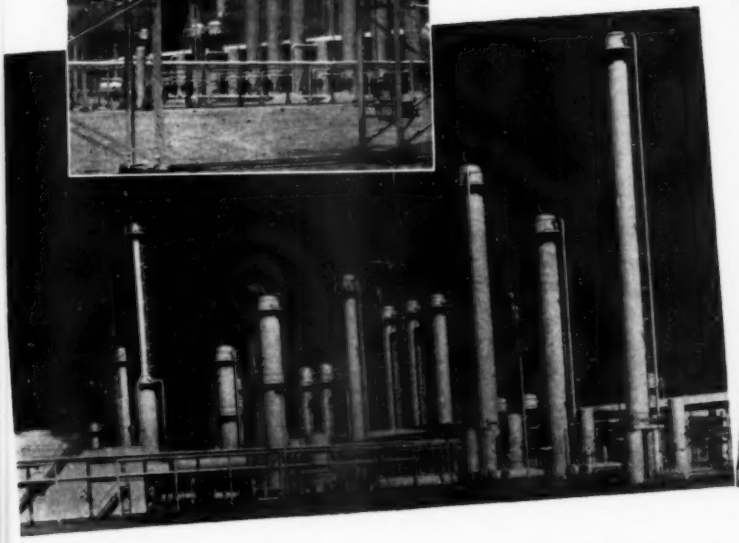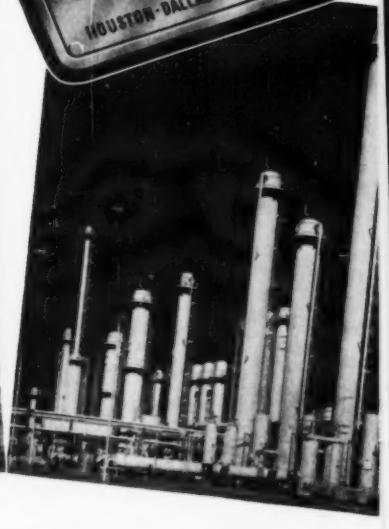
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